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INFORMATION FOR THE AUTHORS

The Turkish Journal of Trauma and Emergency Surgery (TJTES) is an official publication of the Turkish Association of Trauma and Emergency Surgery. It is a peer-reviewed periodical that considers for publication clinical and experimental studies, case reports, technical contributions, and letters to the editor. Six issues are published annually.

As from 2001, the journal is indexed in Index Medicus and Medline, as from 2005 in Excerpta Medica and EMBASE, as from 2007 in Science Citation Index Expanded (SCI-E) and Journal Citation Reports / Science Edition, and as from 2008 in Index Copernicus. For the five-year term of 2001-2006, our impact factor in SCI-E indexed journals is 0.5. It is cited as 'Ulus Travma Acil Cerrahi Derg' in PUBMED.

Submission of a manuscript by electronic means implies: that the work has not been published before (except in the form of an abstract or as part of a published lecture, review, or thesis); that it is not under consideration for publication elsewhere; and that its publication in the Turkish Journal of Trauma and Emergency Surgery is approved by all co-authors. The author(s) transfer(s) the copyright to the Turkish Association of Trauma and Emergency Surgery to be effective if and when the manuscript is accepted for publication. The author(s) guarantee(s) that the manuscript will not be published elsewhere in any other language without the consent of the Association. If the manuscript has been presented at a meeting, this should be stated together with the name of the meeting, date, and the place.

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Open Access Policy: Full text access is free. There is no charge for publication or downloading the full text of printed material.

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Manuscript preparation: Manuscripts should have double-line spacing, leaving sufficient margin on both sides. The font size (12 points) and style (Times New Roman) of the main text should be uniformly taken into account. All pages of the main text should be numbered consecutively. Cover letter, manuscript title, author names and institutions and correspondence address, abstract in Turkish (for Turkish authors only), and title and abstract in English are uploaded to the Journal Agent system in the relevant steps. The main text includes Introduction, Materials and Methods, Results, Discussion, Acknowledgments, References, Tables and Figure Legends.

The cover letter must contain a brief statement that the manuscript has been read and approved by all authors, that it has not been submitted to, or is not under consideration for publication in, another journal. It should contain the names and signatures of all authors. The cover letter is uploaded at the 10th step of the "Submit New Manuscript" section, called "Upload Your Files".

Abstract: The abstract should be structured and serve as an informative guide for the methods and results sections of the study. It must be prepared with the following subtitles: Background, Methods, Results and Conclusions. Abstracts should not exceed 200 words.

Figures, illustrations and tables: All figures and tables should be numbered in the order of appearance in the text. The desired position of figures and tables should be indicated in the text. Legends should be included in the relevant part of the main text and those for photomicrographs and slide preparations should indicate the magnification and the stain used. Color pictures and figures will be published if they are definitely required and with the understanding that the authors are prepared to bear the costs. Line drawings should be professionally prepared. For recognizable photographs, signed releases of the patient or of his/her legal representatives should be enclosed; otherwise, patient names or eyes must be blocked out to prevent identification.

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Journal article: Velmahos GC, Kamel E, Chan LS, Hanpeter D, Asensio JA, Murray JA, et al. Complex repair for the management of duodenal injuries. Am Surg 1999;65:972-5.

Chapter in book: Jurkovich GJ. Duodenum and pancreas. In: Mattox KL, Feliciano DV, Moore EE, editors. Trauma. 4th ed. New York: McGraw-Hill; 2000. p. 735-62.

Our journal has succeeded in being included in several indexes, in this context, we have included a search engine in our web site (www.travma.org.tr) so that you can access full-text articles of the previous issues and cite the published articles in your studies.

Review articles: Only reviews written by distinguished authors based on the editor's invitation will be considered and evaluated. Review articles must include the title, summary, text, and references sections. Any accompanying tables, graphics, and figures should be prepared as mentioned above.

Case reports: A limited number of case reports are published in each issue of the journal. The presented case(s) should be educative and of interest to the readers, and should reflect an exclusive rarity. Case reports should contain the title, summary, and the case, discussion, and references sections. These reports may consist of maximum five authors.

Letters to the Editor: "Letters to the Editor" are only published electronically and they do not appear in the printed version of TJTES and PUBMED. The editors do not issue an acceptance document as an original article for the ''letters to the editor. The letters should not exceed 500 words. The letter must clearly list the title, authors, publication date, issue number, and inclusive page numbers of the publication for which opinions are released.

Informed consent - Ethics: Manuscripts reporting the results of experimental studies on human subjects must include a statement that informed consent was obtained after the nature of the procedure(s) had been fully explained. Manuscripts describing investigations in animals must clearly indicate the steps taken to eliminate pain and suffering. Authors are advised to comply with internationally accepted guidelines, stating such compliance in their manuscripts and to include the approval by the local institutional human research committee.

YAZARLARA BİLGİ

Ulusal Travma ve Acil Cerrahi Dergisi, Ulusal Travma ve Acil Cerrahi Derneği'nin yayın organıdır. Travma ve acil cerrahi hastalıklar konularında bilimsel birikime katkısı olan klinik ve deneysel çalışmaları, editöryel yazıları, klinik olgu sunumlarını ve bu konulardaki teknik katkılar ile son gelişmeleri yayınlar. Dergi iki ayda bir yayınlanır.

Ulusal Travma ve Acil Cerrahi Dergisi, 2001 yılından itibaren Index Medicus ve Medline'da, 2005 yılından itibaren Excerpta Medica / EMBASE indekslerinde, 2007 yılından itibaren Science Citation Index-Expanded (SCI-E) ile Journal Citation Reports / Science Edition uluslararası indekslerinde ve 2008 yılından itibaren Index Copernicus indeksinde yer almaktadır. 2001-2006 yılları arasındaki 5 yıllık dönemde SCI-E kapsamındaki dergilerdeki İmpakt faktörümüz 0,5 olmuştur. Dergide araştırma yazılarına öncelik verilmekte, bu nedenle derleme veya olgu sunumu türündeki yazılarda seçim ölçütleri daha dar tutulmaktadır. PUBMED'de dergi "Ulus Travma Acil Cerrahi Derg" kısaltması ile yer almaktadır.

Dergiye yazı teslimi, çalışmanın daha önce yayınlanmadığı (özet ya da bir sunu, inceleme, ya da tezin bir parçası şeklinde yayınlanması dışında), başka bir yerde yayınlanmasının düşünülmediği ve Ulusal Travma ve Acil Cerrahi Dergisi'nde yayınlanmasının tüm yazarlar tarafından uygun bulunduğu anlamına gelmektedir. Yazar(lar), çalışmanın yayınlanmasının kabulünden başlayarak, yazıya ait her hakkı Ulusal Travma ve Acil Cerrahi Derneği'ne devretmektedir(ler). Yazar(lar), izin almaksızın çalışmayı başka bir dilde ya da yerde yayınlamayacaklarını kabul eder(ler). Gönderilen yazı daha önce herhangi bir toplantıda sunulmuş ise, toplantı adı, tarihi ve düzenlendiği şehir belirtilmelidir.

Dergide Türkçe ve İngilizce yazılmış makaleler yayınlanabilir. Tüm yazılar önce editör tarafından ön değerlendirmeye alınır; daha sonra incelenmesi için danışma kurulu üyelerine gönderilir.

Tüm yazılarda editöryel değerlendirme ve düzeltmeye başvurulur; gerektiğinde, yazarlardan bazı soruları yanıtlanması ve eksikleri tamamlanması istenebilir. Dergide yayınlanmasına karar verilen yazılar "manuscript editing" sürecine alınır; bu aşamada tüm bilgilerin doğruluğu için ayrıntılı kontrol ve denetimden geçirilir; yayın öncesi şekline getirilerek yazarların kontrolüne ve onayına sunulur. Editörün, kabul edilmeyen yazıların bütününü ya da bir bölümünü (tablo, resim, vs.) iade etme zorunluluğu yoktur.

Açık Erişim İlkesi: Tam metinlere erişim ücretsizdir. Yayınlanan basılı materyali tam metni indirmek için herhangi bir ücret alınmaz.

Yazıların hazırlanması: Tüm yazılı metinler 12 punto büyüklükte "Times New Roman" yazı karakterinde iki satır aralıklı olarak yazılmalıdır. Sayfada her iki tarafta uygun miktarda boşluk bırakılmalı ve ana metindeki sayfalar numaralandırılmalıdır. Journal Agent sisteminde, başvuru mektubu, başlık, yazarlar ve kurumları, iletişim adresi, Türkçe özet ve yazının İngilizce başlığı ve özeti ilgili aşamalarda yüklenecektir. İngilizce yazılan çalışmalara da Türkçe özet eklenmesi gerekmektedir. Yazının ana metnindeyse şu sıra kullanılacaktır: Giriş, Gereç ve Yöntem, Bulgular, Tartışma, Teşekkür, Kaynaklar, Tablolar ve Şekiller.

Başvuru mektubu: Bu mektupta yazının tüm yazarlar tarafından okunduğu, onaylandığı ve orijinal bir çalışma ürünü olduğu ifade edilmeli ve yazar isimlerinin yanında imzaları bulunmalıdır. Başvuru mektubu ayrı bir dosya olarak, Journal Agent sisteminin "Yeni Makale Gönder" bölümünde, 10. aşamada yer alan dosya yükleme aşamasında yollanmalıdır.

Başlık sayfası: Yazının başlığı, yazarların adı, soyadı ve ünvanları, çalışmanın yapıldığı kurumun adı ve şehri, eğer varsa çalışmayı destekleyen fon ve kuruluşların açık adları bu sayfada yer almalıdır. Bu sayfaya ayrıca "yazışmadan sorumlu" yazarın isim, açık adres, telefon, faks, mobil telefon ve e-posta bilgileri eklenmelidir.

Özet: Çalışmanın gereç ve yöntemini ve bulgularını tanıtıcı olmalıdır. Türkçe özet, Amaç, Gereç ve Yöntem, Bulgular, Sonuç ve Anahtar Sözcükler başlıklarını; İngilizce özet Background, Methods, Results, Conclusion ve Key words başlıklarını içermelidir. İngilizce olarak hazırlanan çalışmalarda da Türkçe özet yer almalıdır. Özetler başlıklar hariç 190-210 sözcük olmalıdır.

Tablo, şekil, grafik ve resimler: Şekillere ait numara ve açıklayıcı bilgiler ana metinde ilgili bölüme yazılmalıdır. Mikroskobik şekillerde resmi açıklayıcı bilgilere ek olarak, büyütme oranı ve kullanılan boyama tekniği de belirtilmelidir. Yazarlara ait olmayan, başka kaynaklarca daha önce yayınlanmış tüm resim, şekil ve tablolar için yayın hakkına sahip kişilerden izin alınmalı ve izin belgesi dergi editörlüğüne ayrıca açıklamasıyla birlikte gönderilmelidir. Hastaların görüntülendiği fotoğraflara, hastanın ve/veya velisinin imzaladığı bir izin belgesi eşlik etmeli veya fotoğrafta hastanın yüzü tanınmayacak şekilde kapatılmış olmalıdır. Renkli resim ve şekillerin basımı için karar hakemler ve editöre aittir. Yazarlar renkli baskının hazırlık aşamasındaki tutarını ödemeyi kabul etmelidirler.

Kaynaklar: Metin içindeki kullanım sırasına göre düzenlenmelidir. Makale içinde geçen kaynak numaraları köşeli parantezle ve küçültülmeden belirtilmelidir. Kaynak listesinde yalnızca yayınlanmış ya da yayınlanması kabul edilmiş çalışmalar yer almalıdır. Kaynak bildirme "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" (http://www.icmje.org) adlı kılavuzun en son güncellenmiş şekline (Şubat 2006) uymalıdır. Dergi adları Index Medicus'a uygun şekilde kısaltılmalıdır. Altı ya da daha az sayıda olduğunda tüm yazar adları verilmeli, daha çok yazar durumunda altıncı yazarın arkasından "et al." ya da "ve ark." eklenmelidir. Kaynakların dizilme şekli ve noktalamalar aşağıdaki örneklere uygun olmalıdır:

Dergi metni için örnek: Velmahos GC, Kamel E, Chan LS, Hanpeter D, Asensio JA, Murray JA, et al. Complex repair for the management of duodenal injuries. Am Surg 1999;65:972-5.

Kitaptan bölüm için örnek: Jurkovich GJ. Duodenum and pancreas. In: Mattox KL, Feliciano DV, Moore EE, editors. Trauma. 4th ed. New York: McGraw-Hill; 2000. p. 735-62.

Sizlerin çalışmalarınızda kaynak olarak yararlanabilmeniz için www.travma.org.tr adresli web sayfamızda eski yayınlara tam metin olarak ulaşabileceğiniz bir arama motoru vardır.

Derleme yazıları: Bu tür makaleler editörler kurulu tarafından gerek olduğunda, konu hakkında birikimi olan ve bu birikimi literatüre de yansımış kişilerden talep edilecek ve dergi yazım kurallarına uygunluğu saptandıktan sonra değerlendirmeye alınacaktır. Derleme makaleleri; başlık, Türkçe özet, İngilizce başlık ve özet, alt başlıklarla bölümlendirilmiş metin ile kaynakları içermelidir. Tablo, şekil, grafik veya resim varsa yukarıda belirtildiği şekilde gönderilmelidir.

Olgu sunumları: Derginin her sayısında sınırlı sayıda olgu sunumuna yer verilmektedir. Olgu bildirilerinin kabulünde, az görülürlük, eğitici olma, ilginç olma önemli ölçüt değerlerdir. Ayrıca bu tür yazıların olabildiğince kısa hazırlanması gerekir. Olgu sunumları başlık, Türkçe özet, İngilizce başlık ve özet, olgu sunumu, tartışma ve kaynaklar bölümlerinden oluşmalıdır. Bu tür çalışmalarda en fazla 5 yazara yer verilmesine özen gösterilmelidir.

Editöre mektuplar: Editöre mektuplar basılı dergide ve PUBMED'de yer almamakta, ancak derginin web sitesinde yayınlanmaktadır. Bu mektuplar için dergi yönetimi tarafından yayın belgesi verilmemektedir.

Daha önce basılmış yazılarla ilgili görüş, katkı, eleştiriler ya da farklı bir konu üzerindeki deneyim ve düşünceler için editöre mektup yazılabilir. Bu tür yazılar 500 sözcüğü geçmemeli ve tıbbi etik kurallara uygun olarak kaleme alınmış olmalıdır. Mektup basılmış bir yazı hakkında ise, söz konusu yayına ait yıl, sayı, sayfa numaraları, yazı başlığı ve yazarların adları belirtilmelidir. Mektup bir konuda deneyim, düşünce hakkında ise verilen bilgiler doğrultusunda dergi kurallarına uyumlu olarak kaynaklar da belirtilmelidir.

Bilgilendirerek onay alma - Etik: Deneysel çalışmaların sonuçlarını bildiren yazılarda, çalışmanın yapıldığı gönüllü ya da hastalara uygulanacak prosedür(lerin) özelliği tümüyle anlatıldıktan sonra, onaylarının alındığını gösterir bir cümle bulunmalıdır. Yazarlar, bu tür bir çalışma söz konusu olduğunda, uluslararası alanda kabul edilen kılavuzlara ve T.C. Sağlık Bakanlığı tarafından getirilen yönetmelik ve yazılarda belirtilen hükümlere uyulduğunu belirtmeli ve kurumdan aldıkları Etik Komitesi onayını göndermelidir. Hayvanlar üzerinde yapılan çalışmalarda ağrı, acı ve rahatsızlık verilmemesi için neler yapıldığı açık bir şekilde belirtilmelidir.

Yazı gönderme - Yazıların gönderilmesi: Ulusal Travma ve Acil Cerrahi Dergisi yalnızca www.travma.org.tr adresindeki internet sitesinden on-line olarak gönderilen yazıları kabul etmekte, posta yoluyla yollanan yazıları değerlendirmeye almamaktadır. Tüm yazılar ilgili adresteki "Online Makale Gönderme" ikonuna tıklandığında ulaşılan Journal Agent sisteminden yollanmaktadır. Sistem her aşamada kullanıcıyı bilgilendiren özelliktedir.

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EXPERIMENTAL STUDY

Comparison of internal organ injuries by blunt abdominal trauma in rats with empty or full stomach

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ABSTRACT

BACKGROUND: The aim of the study was to investigate if there was a difference in injury in intra-abdominal viscera due to blunt abdominal trauma sustained by rats with empty or full stomach and to examine which viscera is affected most, based on the direction of the trauma.

METHODS: Since there is no data in the literature on the force of trauma, a pilot study was carried out before commencing the experimental study. An apparatus was built to determine the trauma force that would not cause sudden death, and rats were allowed free fall from a height of 40 and 45 cm so that they would land on their abdomen. The most appropriate force of trauma (F=69.978 N) and absorbed energy ($E=\frac{1}{2}mv^2$=0.979 Joules) were obtained in rats weighing 250 g that fell from a height of 40 cm.

RESULTS: Thirty six rats were included in the study and separated into six groups. Any statistically significant differences between groups with regard to the stomach being empty or full during trauma and its direction were examined (anterior, right/left sided).

CONCLUSION: It was observed that there were differences in injuries sustained by the internal organs depending on the fullness or emptiness of the stomach and the direction of the trauma.

Key words: Blunt abdominal trauma; forensic medicine; rat; trauma.

INTRODUCTION

Trauma, one of the most common causes of death in developed countries worldwide,[1-3] is the major reason for death between the ages of 1 and 44. It is the third most common cause of death for people of all ages.[4,5]

The majority of the population (81.8%) is between 0 and 44 years of age in Turkey, and therefore, most of the population is in the risk group for trauma. The most common cause of traumatic death in Turkey is traffic accidents, followed by occupational injuries.[6]

Some abdominal organs are mobile, whereas the position of some is fixed in the body. Organ injuries from blunt trauma to the abdomen vary depending on the relative mobility of the organs. The rate of injury is higher in fixed-position organs compared to the mobile organs in the abdomen. Injuries to organs containing spaces, air, and fluids, such as the gastrointestinal system organs, occur through different mechanisms than injuries to solid organs such as the liver. For instance, blunt trauma to the epigastric area, or the left upper abdominal region, may push the stomach to the back of the abdomen and against the vertebrae, and thus, cause contusion to the stomach. Although blunt trauma rarely causes perforation of the stomach when the stomach is empty, the effects of a similar trauma differ on a full stomach. When the stomach is full, sudden traumatic force generates a hydrostatic pressure transferred by the fluid contents to every point of the stomach, leading to rupture of the stomach.[7]

Blunt trauma to the abdomen most commonly causes organ damage in the spleen, liver, mesenterium, and small intestines, respectively.[8]

In this study, we aimed to experimentally determine whether there were any differences in internal organ damage due to blunt trauma to the abdomen in rats with a full or empty stomach.

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MATERIALS AND METHODS

The study included ten-week-old thirty-six rats having a mean weight of 150-250 g. Rats were purchased from the animal laboratory of Elazig University. This study was approved by the ethics committee and performed following the ethical rules for animal experiments.

There was no previous literature to review for the rate of traumatic force to apply on rats. Therefore, a pilot study was performed following the methodological procedures described by Özel et al.[9] The degree of traumatic force (newton) not causing sudden death but leading to internal organ damage, and the energy (joule) absorbed by rats were determined.

The formulations used to calculate energy in this study are listed below:

h: (height) vertical weight falling height..... m → h: 0.4 m
m: (mass) cracking mass index..... Kg → m: 0.25 Kg
v: (velocity) cracking rate..... m/s
F: (Force) cracking force..... N
E: (Energy) energy absorbed by rats..... J
v = 4.429. √h …….. m/s, → **v** = 4.429x√0.4 m/s, **v** = 4.429x0.632 = 2.799 m/s
F = 100.m.v…… N, → **F** = 442.9.m.√h.N, **F** = 442,9.0,25x.√0,4N, **F** = 69,978 N
E = ½.m.v^2 Joules
We put the value of (v) into the formula and obtained the results below:
F = 442.9.m.√h.....N
F = 442,9.0,25x.√0,4.....N
F = 442,9x0,25x.0,632....N
F = 69.978.....N
E = ½ 0.25x $(4.429\sqrt{0.4}J)^2$
E = 0.979 Joule

To determine a measurable traumatic force, rats whose weight ranged from 200 to 250 g were dropped from a height of 40 and 45 cm to hit the abdominal region in a pre-prepared experimental assembly suggested by Özel et al.[9] (Figure 1). The most convenient traumatic force (F=69.978 N) and rate of absorbed energy (E=0.979 Joules) in rats were determined by testing with a material that was 250 g in weight and dropping it from a height of 40 cm.

Rats were starved for 24 hours. Afterwards, eighteen rats were fed regarding their daily routine. By using this approach, rats were separated into two groups: rats with a full stomach (n=18) and rats with an empty stomach (n=18). After the feeding period, six rats from each group were traumatized from either the anterior, left, or right. Rats were separated into six groups depending on their stomach conditions and the location of the trauma (Table 1). Rats with empty stomachs were divided into three groups regarding whether they were traumatized from the anterior (Group 1), the right (Group 2) or the left (Group 3) (Table 1). Similarly, rats with full stomachs were categorized into three groups (Groups 4, 5, or 6) depending on the location of the trauma, from either the anterior, the right, or the left, respectively (Table 1).

Rats were anesthetized with ketamine and taken to an assembly previously prepared to produce blunt trauma on the abdomen by allowing free falling of rats in frictionless conditions (Figure 1).

A material which was 250 g in weight was applied on rats by free falling of the material from 40 cm height to produce blunt injury on the abdomen. After 30 minutes, rats were decapitated. Any injury on solid and hollow organs of the abdomen was macroscopically examined by an autopsy of rats in the department of forensic medicine in Elazig University. After blunt injury was produced on rat abdomens, any differences in intra-abdominal solid and hollow organ damage were checked in order to ascertain whether full or empty stomach constituted a difference and whether the rats were traumatized from the anterior, or the right or left side.

Data was calculated by average, standard error, and mean. Non-parametric statistical tests, including the Kruskal-Wallis H test and the Mann-Whitney U-test, were used for statistical analysis of data. Statistically significant P values less than 0.05 ($p<0.05$). The SPSS 15.0 for Windows pocket program was used for statistical analysis.

RESULTS

In this study, the frequency of injury on intra-abdominal organs was determined to be highest in liver, followed by spleen and small intestine, respectively (Table 1).

Figure 1. Illustration of assembly prepared for producing trauma.[9]

Table 1. Schematic demonstration of rats' groupings according to the fullness of the stomach and direction of trauma

Groups		L	S	RK*	LK*	PANK*	Sto*	SI*	LI*
1	n	6	6	6	6	6	6	6	6
	Hydrangea	4.166	2.166	0.5	0.5	0.5	0.166	0.5	0.333
	st. deviation	0.752	1.471[e]	0.836	0.836	1.224	0.408	0.836	0.816
	Avarage	4[a]	2.5	0	0	0	0	0	0
2	n	6	6	6	6	6	6	6	6
	Hydrangea	4.333	1	1.333	0.166	0	0	0.5	0
	st. deviation	0.816	0.894	1.211	0.408	0	0	0.836	0
	Avarage	4.5[b]	1[f]	1.5	0	0	0	0	0
3	n	6	6	6	6	6	6	6	6
	Hydrangea	1.166	2.833	0.166	1	0.166	0	0.5	0.5
	st. deviation	0.983	1.169	0.408	1.264	0.408	0	0.836	0.836
	Avarage	1.5[d]	3[c]	0	0.5	0	0	0	0
4	n	6	6	6	6	6	6	6	6
	Hydrangea	2.166	0.833	0.166	0.166	0	1.166	1.166	0.333
	st. deviation	1.471	0.752	0.408	0.408	0	1.169	1.602	0.816
	Avarage	2.5	1	0	0	0	1	0.5	0
5	n	6	6	6	6	6	6	6	6
	Hydrangea	2.166	0.5	0.5	0	0	0.166	0.333	0.333
	st. deviation	1.471	0.836	0.836	0	0	0.408	0.516	0.816
	Avarage	2.5	0	0	0	0	0	0	0
6	n	6	6	6	6	6	6	6	6
	Hydrangea	0.5	1.333	0	0.833	0	0.666	0.5	0.5
	st. deviation	0.836	0.816	0	0.983	0	0.816	0.836	0.836
	Avarage	0	1.5	0	0.5	0	0.5	0	0
Total	n	36	36	36	36	36	36	36	36
	Hydrangea	2.416	1.444	0.444	0.444	0.111	0.361	0.583	0.333
	st. deviation	1.762	1.252	0.808	0.808	0.522	0.723	0.937	0.717
	Avarage	2.5	1	0	0	0	0	0	0
	p-value	<0.001	0.018	0.112	0.240	0.532	0.030	0.950	0.764

a: Difference between Groups 1 and 4 is significant; b: Difference between Groups 2 and 5 is significant; c: Difference between Groups 3 and 6 is significant ($p<0.05$); d: Difference between Group s3 and 6 is not remarkable; e: Difference between Groups 1 and 4 is not remarkable; f: Difference between Groups 2 and 5 is not remarkable ($p>0.05$); *: Differences between Groups 1 and 4, Groups 2 and 5, or Groups 3 and 6 are not remarkable when considering injuries of the right kidney (RK), the left kidney (LK), the pancreas (PANK), the small intestine (SI), the large intestine (LI), the stomach (Sto), and the liver (L).

When considering liver, spleen, and stomach injuries, differences between the groups were statistically significant ($p<0.05$). However, the rate of damage on other organs was not significantly different (Table 1).

Enhancement in the number and grade of solid organ injuries was determined in groups with the empty stomach (Table 1). An enhanced gastrointestinal tract injury was observed in rats with a full stomach; however, this difference was not statistically remarkable (Table 1).

Frequency of damage to the liver differed depending on the direction of trauma and the condition of the stomach. Liver was most frequently injured by trauma from the right (Table 1). When comparing the frequency of liver injury between rats injured from the anterior (Groups 1 and 4) or from the right (Groups 2 and 5), a statistically significant difference was found ($p=0.017$ and $p=0.014$, respectively), while change between rats that were traumatized from the left side (Groups 3 and 6) was not remarkable ($p=0.22$) (Tables 1 and 2, Figures 2 and 3).

Due to blunt trauma, injury was observed especially on the right lobe of the liver. The most frequent complication was determined as a subcapular hematoma, which was followed by laceration of the liver and, less frequently, by deep parenchymal injury.

Spleen was observed to be the second most frequently injured organ in blunt abdominal trauma (BAT). Spleen was most frequently injured by trauma from the left. A significant difference

Table 2. Frequency of injuries to intra-abdominal solid or hollow organs with regard to groups

	Groups	n	Average order		Groups	n	Average order
Liver	1	6	28.92	PANK	1	6	20.58
	2	6	29.92		2	6	17.5
	3	6	11		3	6	20.42
	4	6	16.92		4	6	17.5
	5	6	16.92		5	6	17.5
	6	6	7.33		6	6	17.5
Total		36		Total		36	
Spleen	1	6	24	Stomach	1	6	16.75
	2	6	15.33		2	6	14
	3	6	28.92		3	6	14
	4	6	13.75		4	6	26.58
	5	6	10.42		5	6	16.75
	6	6	18.58		6	6	22.92
Total		36		Total		36	
RK	1	6	19.42	SI	1	6	18
	2	6	26.5		2	6	18
	3	6	16.08		3	6	18
	4	6	16.08		4	6	22
	5	6	19.42		5	6	17
	6	6	13.5		6	6	18
Total		36		Total		36	
LK	1	6	19.42	LI	1	6	18.17
	2	6	16.08		2	6	15
	3	6	23.17		3	6	20.75
	4	6	16.08		4	6	18.17
	5	6	13.5		5	6	18.17
	6	6	22.75		6	6	20.75
Total		36		Total		36	

L: The liver; RK: The right kidney; LK: The left kidney; PANK: The pancreas; SI: The small intestine; LI: The large intestine.

was observed between rats that were traumatized from the left side (Groups 3 and 6) (p=0.018) (Tables 1 and 2).

Injuries to the gastrointestinal tract were mostly observed on the mesenterium or serosa as a hematoma and crush. Perforation in the gastrointestinal system (GIS) was not observed in rats.

On the other hand, although there was a difference between groups with respect to kidney and pancreas injuries produced by BAT, when the direction of trauma or the fullness of the stomach was considered, it was not statistically significant (p>0.05).

In this study, a model was developed and the force of BAT

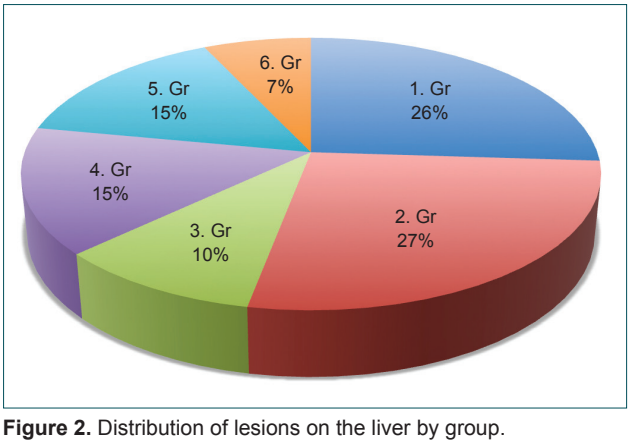

Figure 2. Distribution of lesions on the liver by group.

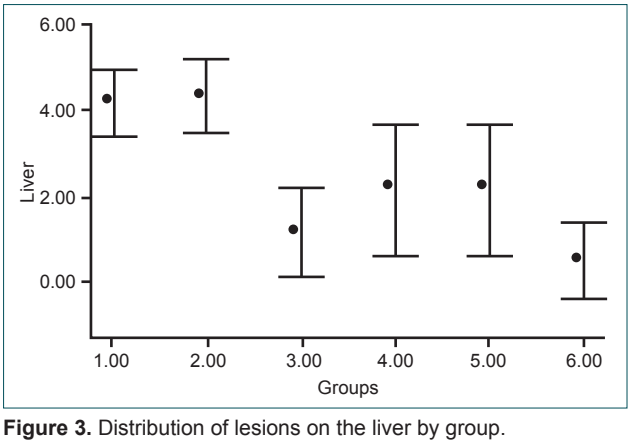

Figure 3. Distribution of lesions on the liver by group.

which would not cause sudden death in rats but would lead to intra-abdominal organ injuries was determined. The frequency and grade of intra-abdominal organ damage involving preventable death due to BAT were aimed to be determined.

DISCUSSION

Injuries are most commonly seen on the head, the extremities, and thirdly on the abdomen. Organ damage is usually caused by blunt trauma.[1-3] Abdominal traumas, which are either penetrating or blunt, result in severe morbidity or mortality. Blunt trauma generally leading to multisystem organ injuries is usually diagnosed late due to its complexity. Although the type of trauma to the abdomen may be either penetrating or blunt, patients die due to abdominal trauma for two reasons: hypovolemic shock, or peritonitis and septic shock due to injuries to intra-abdominal hollow organs. Two percent of patients reaching the hospital alive after blunt trauma develop hemorrhage causing death. Undiagnosed intra-abdominal organ injury is the number one preventable cause of death due to trauma.[10,11]

Liver is the most commonly injured intra-abdominal organ due to BAT caused by traffic accidents. There is no consensus on the mechanisms of liver injury yet. It has been suggested that liver injury could be caused by a crush, crack, or displacement of the liver due to a crash, in addition to liver damage due to the effects of acceleration or deceleration of the liver in response to the sudden stop of a crash.[10,12,13] Moreover, an increase in the pressure of internal fluids due to a high speed crash was also suggested as a plausible cause of liver injury produced by BAT.[14-16] In this study, lesions including crush, crack, and subcapular hematoma in the liver as complications of BAT were observed.

Taviloğlu et al.[17] have found that liver is the most frequently injured organ in two hundred and fifty cases of BAT, and an injury of the liver occurs especially when trauma is from the right side.

Evaluation of one hundred and seven patients with BAT by Holmes et al.[18] have revealed that the liver is damaged in forty-four out of 107 patients, while the spleen was injured in 41 individuals, and 5 patients had a GIS injury.

On the other hand, other studies have suggested that the spleen is the most frequently injured organ and the frequency of damage to the liver is less than to the spleen in cases of BAT.[11] Bruscagin et al. have also determined that spleen is the most frequently injured organ due to BAT.[14,19] In this study, spleen is observed to be the second most frequently injured intra-abdominal organ.

Mortality rates due to liver injury vary between 5% to 25–40% regarding the grade of injury. Mortality increases in high-grade liver injury.[19,20]

In parallel with previous findings, it was determined that injuries occurred most frequently in the liver. However, the grade of liver injury differed depending on the direction of trauma and fullness of the stomach. Liver is most likely to be damaged in rats if trauma came from the right and the stomach is empty. In agreement with previous studies, we also observed that an injury was most likely to occur in the right lobe of the liver.[11,19,20]

In cases with BAT, spleen injury commonly occurs due to trauma from the left affecting the chest.[21] Due to high blood supply to the spleen, that is, 4% of cardiac output, hemorrhage causing death may be observed in spleen injury.[21-25] In this study, intra-abdominal hemorrhage in more than half of the rats was observed to be parallel to previous studies. The results suggested that the spleen was the second most frequently injured organ. A plausible explanation for this could be that the rat spleen is anatomically linked to the tongue and it is more mobile compared to the human spleen.

Moreover, gastrointestinal injury is less frequent than solid organ damage in response to BAT. The damage rate to hollow organs due to BAT has been estimated as 6-10%.[25,26] Different mechanisms play role in damage to organs including perforation of the organ from the effects of a crash and damage from crushing.[27,28] Our observations revealed that injury to the GIS occurred as a crush rather than perforation.

Wessel et al.[29] have conducted a study including three hundred and eight patients with BAT. Injury of the kidney was reported in sixty-seven cases and, moreover, 36 out of these 67 cases had grade 2 damage of the kidney. Our observations revealed that an injury in the kidney was most likely to be grade 1 or 2.

Furthermore, Shinkawa et al.[30] have suggested that a full stomach may play a protective role on other intra-abdominal organs by absorbing the effects of the force produced by a crash like an air cushion, and this protective function may be more significant for the liver, especially when trauma comes from the left.

Intra-abdominal organ injury due to BAT was evaluated in this study and the results suggest that the liver is the most vulnerable organ in response to BAT, followed by the spleen and small intestine, respectively. Frequency and grade of intra-abdominal organ injury was higher in rats with empty stomachs. Considering the frequency of liver injury, the difference between Groups 1 and 6 as well as between Groups 2 and 6 was found to be statistically significant. Moreover, regarding spleen damage, the difference was also statistically remarkable in Group 3 compared to Group 6. Furthermore, GIS injury was higher in rats with a full stomach; however, the difference was not statistically significant.

Considering the low number of current experimental studies

to evaluate BAT, it is our hope that this study will lead to further experimental studies.

Conflict of interest: None declared.

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DENEYSEL ÇALIŞMA - *ÖZET*

Midesi dolu ve boş sıçanlarda künt batın travması sonucu oluşan iç organ yaralanmalarının karşılaştırılması

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AMAÇ: Bu çalışmada, midesi dolu ve boş sıçanlarda künt karın travması (KBT) sonucu karın organlarında yaralanma farklılığı olup olmadığı, travmanın yönüne göre hangi karın organın daha fazla etkilendiği araştırıldı.
GEREÇ VE YÖNTEM: Literatürde kullanılacak travma kuvvetiyle ilgili veri bulunmadığından deneysel çalışmaya geçilmeden önce pilot çalışma yapıldı. Sıçanlarda ani ölüme neden olmayan ölçülebilir travma kuvvetini belirlemek amacıyla kurulan düzenekle 40 cm ve 45 cm'den 200 gr. ve 250 gr. ağırlıklar sıçanların karın bölgesine isabet edecek şekilde serbest düşmeye bırakıldı. En uygun travma kuvveti (F=69.978 N) ve absorbe edilen enerji (E=½.m.v2= 0.979 Joule), 40 cm'den bırakılan 250 gr ağırlıkla elde edildi. Otuz altı sıçan çalışmaya alındı. Sıçanlara ketamin ile anestezi uygulandı. Midenin dolu ya da boş olmasına, travmanın önden, sağdan veya soldan gelmesine göre karın organlarında meydana gelen yaralanmalarda istatistiksel farklılık olup olmadığı araştırıldı.
BULGULAR: En sık karaciğer, dalak ikinci ve ince bağırsakların üçüncü sıklıkta yaralandığı tespit edildi. Karaciğer ve dalak yaralanmaları açısından gruplar arasındaki fark anlamlı bulundu ($p<0.05$). Diger organ yaralanmaları açısından farklılık olmakla birlikte istatistiksel olarak anlamlı değildi.
TARTIŞMA: Midenin dolu ya da boş olmasına ve travmanın yönüne göre karın içi organlarda farklılık olduğu tespit edildi.

Anahtar sözcükler: Adli tıp; künt karın travması; sıçan; travma.

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EXPERIMENTAL STUDY

The fate of suboptimal anastomosis after colon resection: An experimental study

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ABSTRACT

BACKGROUND: The fate of suboptimal anastomosis is unknown and early detection of anastomotic leakage after colon resection is crucial for the proper management of patients.

METHODS: Twenty-six rats were assigned to "Control", "Leakage" and "Suboptimal anastomosis" groups where they underwent either sham laparotomy, cecal ligation, and puncture or anastomosis with four sutures following colon resection, respectively. At the fifth hour and on the third and ninth days; peripheral blood and peritoneal washing samples through relaparotomy were obtained. The abdomen was inspected macroscopically for anastomotic healing. Polymerase chain reaction (PCR) with 16s rRNA and *E.coli-specific* primers were run on all samples along with aerobic and anaerobic cultures.

RESULTS: The sensitivity and specificity of PCR on different bodily fluids with 16s rRNA and *E.coli-specific* primers were 100% and 78%, respectively. All samples of peritoneal washing fluids on the third and ninth days showed presence of bacteria in both PCR and culture. The inspection of the abdomen revealed signs of anastomotic leakage in eight rats (80%), whereas mortality related with anastomosis was detected in two (20%).

CONCLUSION: Anastomotic leakage with suboptimal anastomosis after colon resection is high and the early detection is possible by running PCR on peritoneal samples as early as 72 hours.

Key words: Anastomotic leakage; colorectal anastomosis; early detection; polymerase chain reaction; suboptimal anastomosis.

INTRODUCTION

Anastomotic leakage is one of the most feared complications of colorectal surgery. Although reported rates of anastomotic leakage vary between 1% and 23%, 3% to 6% rate is considered acceptable for modern surgery.[1] Besides many negative impacts on patient's morbidity, mortality and life quality, it is also associated with higher tumor recurrence rate and poor survival.[2,3]

Wide variations in reported incidences of colorectal anastomotic leakage are partly due to lack of consensus on the definition. There have been several reports using highly variable definitions of anastomotic leakage in colorectal surgery.[4] A recent consensus definition of anastomotic leakage as "a communication between intra-and extraluminal compartments owing to a defect of the integrity of the intestinal wall at the anastomosis between colon and rectum or the colon and anus" has been proposed by International Study Group of Rectal Cancer.[4] Although more general, UK Surgical Infection Study Group has also defined anastomotic leakage as the "leak of luminal contents from a surgical join between two hollow viscera".[5] While many studies used clinical signs

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of peritonitis such as fever, tachycardia, leukocytosis, and etc.; some used radiological findings detected by computed tomography (CT) or other modalities. Lack of consensus in detection methods could partly explain the reason of great variations in the incidence and outcome of the leakage.

Although clinical anastomotic leakage has received great interest in surgery, the fate of suboptimal anastomosis is largely unknown. Since the presenting clinical symptoms are often vague and confused with benign postoperative complications, the true rate of anastomotic leakage is difficult to estimate. It is important to distinguish leakage from such benign conditions to act as early as possible in order to avoid severe consequences. The luminal contents leaked into peritoneum are principally cleared by local defense mechanisms. However, bacteria in the peritoneum can easily find access to the bloodstream in a very short time.[6] The early detection of microorganism in the peritoneum and blood could alter the management of the patient. Since conventional methods of bacterial detection such as culture is sometimes insufficient, molecular techniques like polymerase chain reaction (PCR) could be of assistance. PCR has been shown to detect small amount of bacteria in different bodily fluids with great success.[7] However, the role of PCR in the early detection of anastomosis is not clearly depicted.

This experimental study was designed to understand the fate of suboptimal anastomosis and explore the possibility of early diagnosis of leakage in colon anastomosis by means of detecting bacterial DNA in different bodily fluids by polymerase chain reaction. It was also aimed to evaluate the efficacy of PCR in anastomotic leaks.

MATERIALS AND METHODS

Animals

The local Animal Ethics Committee of Istanbul University, Faculty of Medicine approved the experiment (Protocol number: 28/2005, Protocol Date: 20.09.2005). Twenty-six male Wistar rats weighing 200-250 grams were used. National Research Council guidelines were followed for the use and care of the animals. Briefly, the animals were put two per cage, fed on standard chow, and let free access to water. They were observed for two weeks before the experiment started. They were allowed to eat and drink before and after the operation. The animals were followed for two months after the operation.

Experimental Design

The animals were randomly assigned to three groups: Group I was the "control group" consisted of eight animals which underwent sham laparotomy. Five hours after the operation, peripheral blood sample was obtained to evaluate any bacterial contamination by PCR and culture. Group II was the "leakage group" and consisted of eight animals. After laparotomy, the cecal ligation and puncture were performed and the abdomen was closed. Five hours later, peripheral blood was withdrawn and both PCR and culture were run on blood samples to detect bacterial presence. The rats were then sacrificed. Group III was the "suboptimal anastomosis group" and consisted of ten animals. After laparotomy, resection of the left colon and anastomosis were performed. Five hours, three and nine days after the operation, peripheral blood samples were taken to run PCR and culture. On the third and ninth days, the rats underwent relaparatomy. Peritoneal fluid collections were obtained for both PCR and culture. The abdomen was inspected and anastomosis was evaluated macroscopically for healing. Experimental design was summarized in Figure 1.

Procedures and the Operation

All interventional procedures and operations were performed under strict sterility and dissociative anesthesia. Intramuscular 90 mg/kg ketamine HCl (Ketalar, Parke-Davis, Eczacibasi, Turkey) was used for anesthesia. Peripheral blood to study the bacteremia with PCR and culture was withdrawn from the femoral region. In order to prevent contamination from skin bacteria, the femoral region was cleaned with polyvinyl pirolidon iodine (Batticon, Adeka, Turkey). Groin region was covered with sterile drapes and an incision of 2 cm was made. Under sterile conditions, femoral artery was found and 1 to 2 ml of blood was withdrawn into 2 Na2EDTA containing sterile tubes. One blood sample was used for DNA isolation and placed on ice immediately and transferred to -20°C freezers until analysis. The blood in the second tube was inoculated into cultural medium. For each time point, opposite site of the femoral region from the previous attempt was used to minimize the contamination risk. The femoral region was sutured after the procedure under sterile condition.

Laparotomies were performed via 3-cm midline incisions after cleaning the surgical area with povidone iodine and covering with sterile drapes. The area was covered to prevent spillage. A segment of left colon was isolated and resected without compromising the vasculature network. Anastomosis of the resected colon was performed with four sutures using 4/0 vicryl suture. The use of less than five sutures in anastomosis has been defined as a model for suboptimal anastomosis.[8] Then, the abdominal wall and skin were closed with 3/0 silk sutures.

Seventy-two hours later, the animals were prepared for peripheral blood withdrawal under anesthesia with strict adherence to asepsis, as described. After the closure of the femoral incision, the abdomen was incised and subcutaneous tissue was inspected for abscesses. In case of abscess, discharge sample was obtained for both PCR and culture. Abdominal wall was opened through previous sutures. Without touching the abdominal organs, abdominal cavity was washed with 2 ml of sterile saline and the fluid was collected with a syringe. Afterwards, inspection of the abdomen and anastomosis was

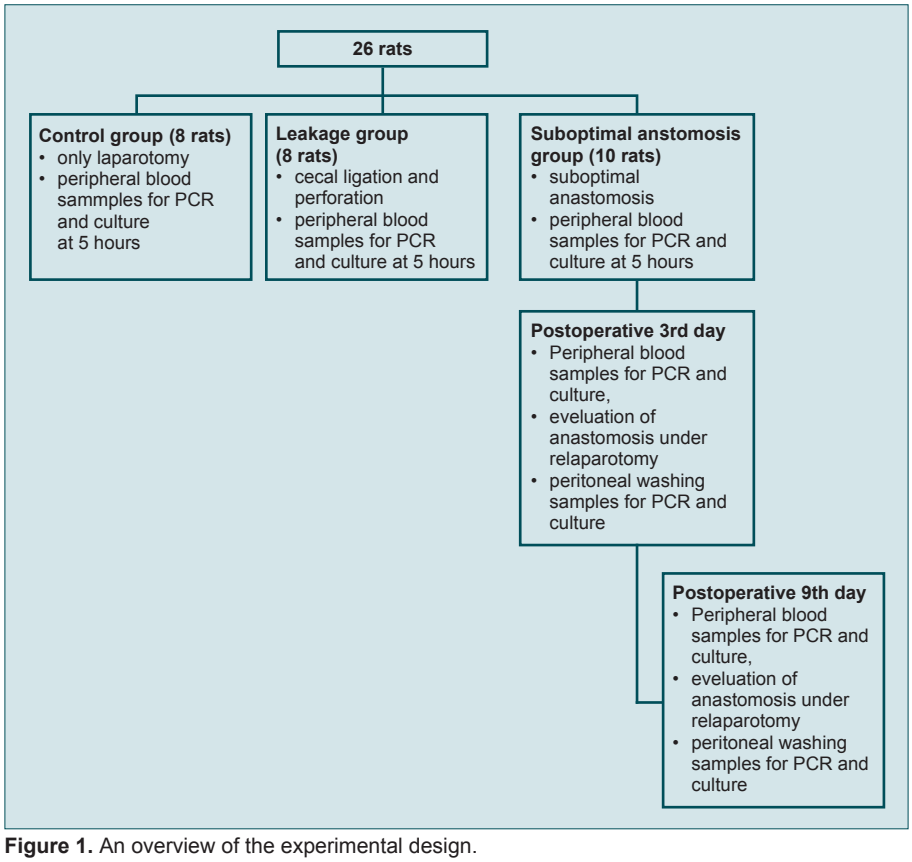
26 rats
Control group (8 rats)
• only laparotomy
• peripheral blood sammples for PCR and culture at 5 hours
Leakage group (8 rats)
• cecal ligation and perforation
• peripheral blood samples for PCR and culture at 5 hours
Suboptimal anstomosis group (10 rats)
• suboptimal anastomosis
• peripheral blood samples for PCR and culture at 5 hours
Postoperative 3rd day
• Peripheral blood samples for PCR and culture,
• eveluation of anastomosis under relaparotomy
• peritoneal washing samples for PCR and culture
Postoperative 9th day
• Peripheral blood samples for PCR and culture,
• eveluation of anastomosis under relaparotomy
• peritoneal washing samples for PCR and culture

Figure 1. An overview of the experimental design.

performed. Any collections in the abdominal cavity were noted and anastomosis was evaluated. The leak was considered in the case of gross contamination with luminal content, the presence of healing defect in anastomosis, the presence of small abscess around anastomosis, and the omental attachment covering the healing defect. The abdomen was closed in an orderly fashion. After nine days, the same procedures with peripheral blood withdrawal and anastomosis evaluation were repeated. The animals were followed for a two-month-period for observation. Any animal lost during study period underwent autopsy and the abdominal cavity and anastomosis were evaluated.

The Detection of Bacterial DNA in the Blood and Peritoneal Fluid

DNA Isolation

All samples collected from each animal were stored at -20°C. For the extraction of DNA, 200-400 uL blood, whole blood or peritoneal wash fluid were used. DNA was extracted from whole blood or peritoneal fluid using the DNA extraction kit (Roche Diagnostics GmbH, Mannheim, Germany,) according to the manufacturer's protocol. DNA samples were stored at -20°C.

Polymerase Chain Reaction

Two primer pairs were used for the detection of bacteria. First set of primers (540 bp) were used to amplify prokaryotic 16S rRNA for the detection of any bacterial contamination regardless of origin: 355F (5'-CCTACGGGAGGCAGCAG-3'), and 910R (5'-CCCGTCAATTCCTTTGAGTT -3').[9] The second set of primers (486 bp) were used to amplify β- glucuronidase of *Escherichia coli* to detect *E. coli* specifically: P1 (5'-ATCACCGTGGTGACGCATGTCGC-3') and P2 (5'-CACCACGATGCCATGTTCATCTGC-3').[10] 40 ul of reaction mixture was formed from 1x PCR buffer, 3.5 mmol/L $MgCl_2$, 2 U Taq DNA polymerase, 800 µmol/L dNTP mix, 1 µmol/L primer 1, and 1 µmol/L primer 2, and 10 ul extracted DNA was used for the 50 ul of total volume of PCR mixture. The amplification reaction consisted of one cycle of 5 min at 94°C and 35 cycles of 45 s of denaturation at 94°C, 45 s of annealing at 55°C, and 60 s of extension at 72°C, with a final extension cycle of 10 min at 72°C. At the end of the program, 10 ul of the amplification product was detected by electrophoresis on 1.5% agarose gel with ethidium bromide staining, and the products were then photographed under UV light (304 nm). The amplified DNA products (16s rRNA, 540 bp; and *E. coli*-specific, 486 bp) were compared with control DNA and molecular weight standards.

Cultures

One ml of blood and peritoneal samples collected from rats were inoculated into BACTEC aerobic and anaerobic medium bottles (Becton Dickinson, Sparks, Md.) in order to detect

bacterial growth. After incubation for seven days at 37°C, the bottles were punctured under sterile conditions, and 100 µl was subcultured onto sheep blood (5%) agar and MacConcey agar medium. A subculture was incubated in anaerobic conditions at the same time. The subcultures were incubated for 72 hours at 37°C. If bacterial growth was detected, the bacteria were identified according to standard microbiological methods.

Statistical Analysis

The sensitivity, specificity, negative and positive predictive value of PCR compared to culture was calculated. Presence of bacterial DNA in either *E. coli* or 16s rRNA, PCR was accepted as positive. Being negative in PCR meant both PCR samples (*E. coli* and 16s rRNA) didn't detect any bacterial DNA.

RESULTS

General

Two mortalities were observed in the suboptimal anastomosis group, while no mortality was detected in the control group. One of the rats died at the forty-eighth hour. Blood samples for both PCR and culture were positive at the fifth hour of anastomosis and *E. coli, Klebsiella sp.* and *Bacteroides fragilis* were identified from culture. Exploration of the abdomen revealed complete dehiscence of anastomosis with gross fecal contamination. The PCR and cultures run on blood sample at the forty-eighth hour and peritoneal washing cultures were positive for *E. coli* and *B. fragilis*. The second rat died on the sixteenth day of anastomosis. PCR and cultures from blood and peritoneal samples until postoperative ninth day were all negative for any bacterial presence. However, on ninth day, blood and peritoneal samples showed positivity for PCR. Culture identified *E. coli*, *K. pneumoniae* and *B. fragilis*. Nevertheless, inspection of the abdomen on the ninth day didn't show any gross contamination of fecal material and anastomosis healing was normal. On postmortem examination sixteenth day, complete dehiscence of anastomosis with gross contamination of abdomen was noted.

The inspection of anastomosis on postoperative third day revealed that 80% of anastomosis showed some signs of anastomotic leakage either at one time point or both (Fig. 3). Leaked anastomosis were covered by omentum and associated with microabscesses showing some signs of inflammation. On ninth day, more anastomosis appeared healed macroscopically (66%).

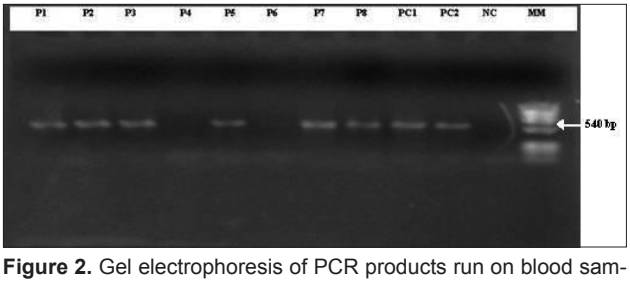

Figure 2. Gel electrophoresis of PCR products run on blood samples obtained at the fifth hour from the rats. (PC: Positive control, NC: Negative control; MM: Molecular marker; P1-P8: blood samples of the rats from leakage group. 16 s r RNA primers were used).

The Sensitivity and Specificity of PCR

Sixty eight samples (blood, peritoneal washings, wound and abcesses) from 26 rats were cultured. Two PCRs, one with E. coli primers and other with 16s rRNA primers, were run on each sample ending up with a total number of 136 PCRs. The sensitivity and specificity of PCR with both *E. coli* primers and 16s rRNA primers on samples from different body fluids were found 100% and 78%, respectively (Table 1). The accuracy of PCR samples from blood, peritoneal washings, and wound abscesses changed from 84% to 100% depending on the primers and the sample type. The sensitivity of PCR was 100%, regardless of the primers and sample type, while the specificity changed between 57 and 100% depending on primers and samples. The negative predictive value of PCR was found 100%. However, the positive predictive value was between 65 to 100%. The details of sensitivity, specificity and accuracy with the use of different primers on different bodily fluids were shown in Table 2. The accuracy of PCR using *E. coli* primers on any sample (97%) was greater than the one using 16s rRNA primers (88%).

Early Detection of Bacterial DNA in the Blood of Rats With Gross Abdominal Leak

Animals in the leakage group served as control group for the gross bacterial contamination. After five hours of cecal ligation and puncture, the animals were sick-appearing with tachypnea and lethargy. The culture performed on blood

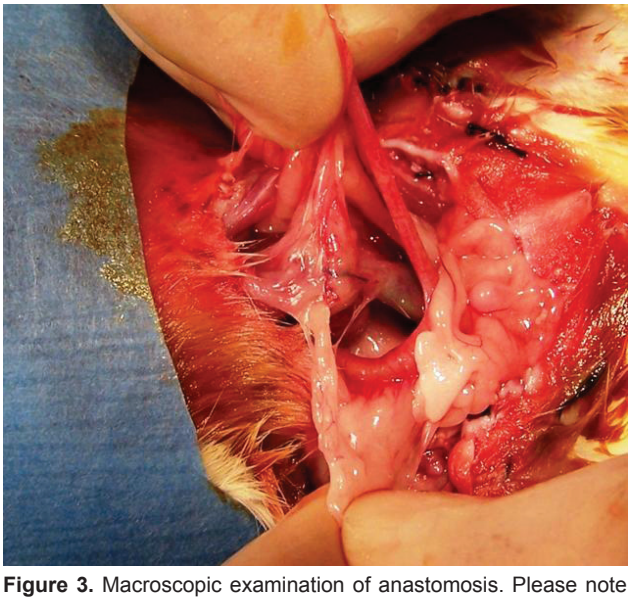

Figure 3. Macroscopic examination of anastomosis. Please note suture and adhesions, edema and inflammation around the anastomosis.

Table 1. Comparison of PCR with *E. coli* primers and 16s rRNA primers run on different body fluids with corresponding cultures

		Culture		
		Positive	**Negative**	
PCR	Positive	35 (TP)	7 (FP)	83% PPV TP / (TP + FP)
	Negative	0 (FN)	26 (TN)	100% NPV TN / (TN + FN)
		35	33	68
		100% Sensitivity TP / (TP + FN)	78% Specificity TN/(FP+TN)	

TP: True positive; FP: False positive; PPV: Positive predictive value; FN: False negative; TN: True negative; NPV: Negative predictive value.

samples at postoperative fifth hour from 75% of rats revealed bacterial growth (n=6/8). PCR using with *E. coli* primers revealed no positivity. However, same PCR reaction with 16s rRNA primers revealed a complete overlap with culture positivity (Fig. 2). The isolated bacteria from culture were monobacterial in five rats (*B. fragilis* in four rats, *Enterococcus sp.* in one rat), and multibacterial in one. *B. fragilis* was the most frequently isolated bacteria in the leakage group (83%). In this group of animals, the accuracy, sensitivity and specificity of PCR were 100%. In the control group with only laparotomy, both PCR with *E. coli* and 16s rRNA primers and culture were negative for bacterial contamination or growth.

The Detection of Bacteria in the Blood of Rats With Suboptimal Anastomosis

Five hours after anastomosis, PCR on the blood withdrawn from femoral vein showed two positive results. One had not been confirmed with culture. However, the other one was confirmed with culture since *E. coli*, *B. fragilis*, and *K. pneumoniae* were identified. The rat had gross anastomosis leak on second day of exploration and died. The positivity of bacterial detection at the fifth hour was 20%.

On the third day of anastomosis, three rats showed positivity of bacterial DNA in the PCR. However, the cultures of two rats didn't confirm positivity and correlate with gross anastomosis leak ending with excitus. The only positive result correlating with the culture was the blood sample obtained earlier from the heart of the rat which died at the forty-eighth hour due to anastomotic leak. Therefore, the positivity of bacterial DNA at 72 hours in blood was 30%.

On postoperative ninth day, PCR with *E. coli* primers was positive on 33% of rats, whereas PCR with 16s rRNA primers showed 88% positivity. Culture showed 60% positivity on blood. However, the identified bacteria from two cultures showed methicilline sensitive *S. aureus*, which could possibly result from contamination of skin flora. Therefore, if culture positivity with intestinal flora is taken into account, the positivity decreases to 40%. Table 3 summarizes the results.

Table 2. The sensitivity, specificity, NPV (negative predictive value), and PPV (positive predictive value) of PCR with different primers on different body fluids compared with corresponding cultures

	***E. coli* primers**			**16s rRNA primers**		
	All samples (%)	**Blood (%)**	**Peritoneal fluid (%)**	**All samples (%)**	**Blood (%)**	**Peritoneal fluid (%)**
Sensitivity	100	100	100	100	100	100
Specificity	93	100	57	75	78	0
PPV	87	100	80	81	65	95
NPV	100	100	100	100	100	NC

Table 3. PCR and culture results from blood samples of suboptimal anastomosis group

Rat	5th h	3rd d	9th d	Culture 3rd d / 9th d	Anastomotic leak	Mortality
1	N	N	P16sRNA	Sterile / Sterile	Yes	No
2	N	N	P16sRNA	Sterile / MSSA	No	No
3	N	P16sRNA	P16sRNA	Sterile / MSSA	Yes	No
4	N	N	P16sRNA	Sterile / Sterile	Yes	No
5	N	N	PEc+16sRNA	Sterile / *E. coli*	Yes	No
6	P16sRNA	P16sRNA	P16sRNA	Sterile / Sterile	Yes	No
7	N	N	PEc+16sRNA	Sterile / *E. coli, B. fragilis*	Yes	No
8	P16sRNA	N	N	Sterile / Sterile	Yes	No
9	P16sRNA	PEc+16sRNA*	NA	*K. pneumonia*# *E.coli**, *B. fragilis**/ NA	Yes	Yes
10	N	N	PEc+16sRNA	Sterile / *E. coli*	No	Yes
%	30%	30%	88%	40%*	80%	20%

N: Negative; PEc: Positive PCR with *E.coli* primers; P16sRNA: Positive PCR with 16s rRNA primers; PEc+16sRNA: Positive PCR with *E.coli* and 16 s r RNA primers. *Denotes the blood sample obtained at 48 hours of anastomosis. #Shows the culture result obtained at 5 hours after anastomosis.

Table 4. PCR and culture results from blood samples of suboptimal anastomosis group

Rat	3rd day	9th day	Culture 3rd d / 9th d	Anastomotic leak	Mortality
1	PEc+16sRNA	P16sRNA	*E. coli* / MSSA	Yes	No
2	PEc+16sRNA	P16sRNA	*E. coli / K. pneumonia*	No	No
3	PEc+16sRNA	PEc+16sRNA	*E. coli, Fusobacterium / E. coli*	Yes	No
4	PEc+16sRNA	P16sRNA	*E. coli / K. pneumonia*	Yes	No
5	PEc+16sRNA	PEc+16sRNA	*E. coli / E. coli*	Yes	No
6	P16sRNA	PEc+16sRNA	*B. fragilis / E. coli*	Yes	No
7	PEc+16sRNA	PEc+16sRNA	Sterile / *Proteus spp.*	Yes	No
8	PEc+16sRNA	PEc+16sRNA	*K. pneumonia, MSSA / E. coli, B. fragilis*	Yes	No
9	PEc+16sRNA*	NA#	*E. coli**/ NA	Yes	Yes
10	PEc+16sRNA	PEc+16sRNA	*E. coli / E. coli*	No	Yes
	100%	100%	100%	80%	20%

PEc: Positive PCR with E.coli primers; P16sRNA: Positive PCR with 16s rRNA primers; PEc+16sRNA: Positive PCR with E.coli and 16 s r RNA primers. *Denotes the sample obtained at 48 hours of anastomosis. #The rat died at 48 hours due to anastomotic leak.

The Detection of Bacteria in the Peritoneal Washing of Rats with Suboptimal Anastomosis

On postoperative third and ninth days, 100% PCR positivity for bacterial DNA was detected. However, on the third day, 90% of the culture was positive. On postoperative ninth day, culture positivitiy was 100%. The bacteria isolated from peritoneal washings were all from intestinal flora. In three cultures, MSSA was isolated additionally to gram negative or anaerobic bacteria, which could more likely come from contamination of the surgical procedures. *E. coli* was present in 90% of the culture. The details were shown on Table 4.

DISCUSSION

Early diagnosis of anastomotic leakage and subsequent treatment are essential for the prognosis and prevention of devastating consequences. It has been shown that reoperation of the patients with anastomotic leakage before postoperative day five of index surgery significantly reduces the mortality compared to patients operated after day five.[11] However, presenting symptoms and timing of the leak vary greatly. Majority of the reports consider gross indicators of clinical situations like peritonitis. However, many patients present with vague or weak symptoms of neurological and respiratory ori-

gin, which could easily be confused.[12] In many studies, anastomotic leakage has appeared between postoperative seventh and twelfth days with gross signs of peritonitis and systemic sepsis. Traditional signs and symptoms of an anastomotic leak such as elevated white blood cell level (WBC), fever, and peritonitis usually develop as late as postoperative 5-7 days. The return of bowel function after colorectal resection and anastomosis does not preclude the possibility of a leak.[12] Besides clinical indicators, many biochemical and radiological tests have been studied with the expectation of timely diagnosis.[13,14] A recent study using CRP as an indicator of anastomotic leakage after colorectal resection showed that higher levels might help to detect the leage before becoming clinically apparent.[15] The detection of cytokines through intraperitoneal microdialysis has also been implicated as a tool for detection of anastomotic leakage prior to the emerging of clinical symptoms.[16] However, none of the methods have been proven effective and accepted universally.

The fate of bacteria in peritoneal cavity has been studied substantially during last decades. It has been shown that intraperitoneal elimination starts immediately and continues for approximately six hours.[17] The bacteria gain access to circulating blood through the pores located in the abdominal part of the right diaphragm to the thoracic duct and eventually to peripheral blood circulation. The process is very rapid, since the bacteria could be observed in the thoracic duct as early as 6 to 10 min after intraperitoneal injection and in the blood after 30 to 40 min.[18] The blockade of absorption from peritoneal cavity by destruction of diaphragmatic pores decreased the positive blood culture and increased the survival time in rats with double colonic perforation.[19] However, the detection of small amount of bacteria in blood by conventional methods like blood culture could be ineffective especially in postoperative period while the patient is under antibiotic regime. Recently, PCR based molecular methods have gained acceptance in many aspects of clinical application. The detection of the amount of bacteria in various bodily fluids, like blood, using PCR with specific primers designed from bacterial DNA could be accomplished, even when the patient is under antibiotic treatment.[7,20]

The fate of suboptimal anastomosis in humans is largely unknown. There are few reports on minor anastomotic leaks and their comparisons with major ones. Recently, an experimental model of suboptimal anastomosis has been introduced. The authors claim that an animal model of colorectal anastomotic leakage can be created with five interrupted sutures resulting with 44% of anastomotic leak.[8] In this study, four interrupted sutures were used to establish anastomosis and 80% of the anastomotic leak was detected with inspection. The bacteria were detected by both PCR and culture in the peritoneal washings (100% and 90%, respectively). Even as late as the ninth day after anastomosis, PCR and culture showed 100% positivity with bacteria. The identification of bacteria from culture was clearly from intestinal origin. Based upon our results, it can be suggested that most anastomosis after suboptimal suturing has leaks continuing even after the clinical healing has occurred. Although anastomotic leak continues microbiologically, the healing process becomes completed except in 20% of anastomosis, which ended up with mortality. This figure also comprised late anastomotic leaks, since the rats were followed for two months after anastomosis. It can be concluded that in suboptimal anastomosis, although anastomotic leak is present microscopically, the leak ending up with mortality only comprises 20%. Our result and clinical experience show that not all anastomotic leakages end up with devastating complications. A variety of different clinical presentations ranging from asymptomatic cases to severe peritonitis ending up with mortality could be seen. While some leaks are contained and healed without intervention, some requires surgery. The question of how a leak will progress could be influenced by many facors related with the host (immune response, genetic variations like single nucleotide polymorphism in critical genes controlling the inflammation), amount of leakage, origin of the leak like from the small or large intestine, virulence of bacteria, and etc. Therefore, the experimental model of suboptimal anastomosis can be used to titrate and investigate the variables controling the outcome of anastomotic leakages.

The use of PCR in different bodily fluids has been studied with great success.[21-24] The PCR method has been found to be more sensitive than blood cultures for detecting bacterial presence in the blood of critically ill surgical patients.[7] The detection of bacterial DNA in the blood of patients with liver cirrhosis, acute pancreatitis, and major abdominal surgery has also been reported.[25-27] The use of PCR in an experimental model of anastomotic leakage has already been shown in a study where the authors claim that the detection of microbial DNA in blood might be used in patients with dubious findings suggesting anastomotic leakage.[28] In this study, it was shown that the sensitivity of PCR was 100%, while the specificity changed between 57% and 100%. Hence, the negative predictive value of PCR was perfect as shown earlier. In other words, by negative PCR any infectious source can be ruled out. Low positive predictive level was expected since the detected DNA could come from dead organisms, which had already been phagocytosed and engulfed. The difference between the detection rates of anastomotic leakages (100% with PCR and culture, 80% by inspection) could partly be explained by the sensitivity of PCR. Furthermore, a miniscule anastomotic leakage can be missed by the naked eye, while PCR and culture are more sensitive since they detect the bacterial contamination to the peritoneum. The bacterial detection in suboptimal anastomosis either by PCR or culture at both time points from peritoneal washings was significantly higher than the blood. Using peritoneal washing solutions, PCR can detect the presence of bacteria significantly earlier and more precisely than blood. In the presence of anastomotic leakage, the management mainly depends on the patient's clinical situation and response. However, there

are some circumstances where symptoms are dubious to suggest anastomotic leakage. Although the decision will still be clinically oriented, earlier diagnosis of anastomotic leakage strongly helps clinicians to direct the treatment. Indeed, there are some clinical studies attempting to use peritoneal fluid to detect anastomotic leakages earlier than the clinical symptoms. Matthiessen et al.[16] have collected intraperitoneal cytokines, IL-6, IL-10, and TNF-alfa through a pelvic drain from patients who underwent anterior resection for rectal cancer. They have concluded that through intraperitoneal monitoring of cytokines anastomotic leakage might be detected before clinical symptoms are manifested. A recent article by Fouda et al.[29] checked the utility of intraperitoneal cytokine concentration and detection of bacteria in patients who underwent low anterior resection due to rectal cancer. Peritoneal samples were collected from the abdominal drains on the first, third, and fifth days postoperatively for peritoneal microbiological study and cytokine (IL-6, IL-10, TNF) level measurement. They found that intraperitoneal bacterial colonization and cytokine levels were significantly higher in patients with anastomotic leakages, concluding that the technique could be used as an adjunct to the decision of the surgeon for colorectal anastomotic leakages. Therefore, early detection of bacteria in peritoneal samplings by PCR and culture in patients with colorectal anastomosis could be an alarming sign of anastomotic leak.

The present study indicated that with suboptimal anastomosis, although anastomotic leakage was very high, clinically significant anastomotic leak was rather infrequent. Early detection of anastomotic leakage was possible by running PCR on peritoneal samples as early as 72 hours. The clinical significance of the use of peritoneal washing samples from colorectal anastomosis remains to be determined.

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DENEYSEL ÇALIŞMA - *ÖZET*

Kolon rezeksiyonları sonrası suboptimal anastomoz: Deneysel çalışma

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AMAÇ: Suboptimal anastomozun nasıl sonuçlanacağı bilinmemektedir. Kolon rezeksiyonları sonrası anastomoz kaçağının erken tanısı hastanın doğru yönetiminde çok önemlidir.
GEREÇ VE YÖNTEM: Yirmi altı sıçan "kontrol", "kaçak" ve "suboptimal anastomoz" adıyla üç gruba ayrıldı. Sırasıyla gruplara sham laparotomi, çekum ligasyonu-perforasyon ve kolon rezeksiyonu sonrası dört dikişle anastomoz yapıldı. Beşinci saatte, üçüncü ve dokuzuncu günlerde periferden kan örnekleri ve relaparotomi sonrası periton yıkama örnekleri alındı. Karnın içi makroskopik anastomoz kaçağı varlığı için incelendi. Alınan yıkama örneklerinden aerobik ve anaerobik kültürlerle beraber 16 RNA ve *E. Coli*'ye özgü primerler kullanılarak polimeraz zincir reaksiyonu (PZR) yapıldı.
BULGULAR: Değişik vücut sıvılarında 16 s RNA ve *E. coli*'ye özgün primerler kullanılarak yapılan PZR'nin sensitivitesi ve spesifisitesi sırasıyla %100 ve %78 olarak bulundu. Üçüncü ve dokuzuncu günlerde alınan periton yıkama sıvılarında hem kültürde hem de PZR'de bakteri varlığı gösterildi. Karın içinin incelenmesinde 8 (%80) sıçanda anastomoz kaçağı işaretleri gözlenirken, anastomozla ilişkili mortalite sadece 2 (%20) sıçanda saptandı.
TARTIŞMA: Kolon rezeksiyonu sonrası suboptimal anastomoza bağlı anastomoz kaçağı oranı yüksektir ve 72 saat gibi erken bir sürede periton örneklerinden yapılan PZR ile tanı koymak olasıdır.
Anahtar sözcükler: Anastomoz kaçağı; erken tanı; kolorektal anastomoz; polimeraz zincir reaksiyonu; suboptimal anastomoz.

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EXPERIMENTAL STUDY

Effects of citicoline on level of consciousness, serum level of fetuin-A and matrix Gla-protein (MGP) in trauma patients with diffuse axonal injury (DAI) and GCS≤8

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ABSTRACT

BACKGROUND: Citicoline, a neuroprotective drug, has been suggested to improve level of consciousness, mitigating secondary to brain damage and ectopic vascular calcification, following post-traumatic neurogenesis and angiogenesis, inducing calcification modulators, like fetuin-A and matrix Gla-protein (MGP). This study aimed to investigate effects of citicoline on levels of consciousness, serum levels of fetuin-A and MGP in patients with severe traumatic brain injury.

METHODS: This double blind randomized controlled trial (RCT) was conducted on patients with diagnosis of diffuse axonal injury (DAI) and GCS≤8. The cases were treated with citicoline (500 mg every 6 hours) intravenously for fifteen days. Daily GCS assessment and intermittent blood sampling were done for both cases and controls.

RESULTS: Fifty-eight patients were included in the study and during the study period, mean GCS levels improved in both groups; however, the difference was inconsiderable (p>0.05). Serum levels of fetuin-A, a negative phase reactant, increased in the group treated with citicoline (p=0.012), while these changes were insignificant for the controls (p=0.455). Serum levels of MGP, a calcification inhibitor, increased in the cases (p=0.046). The alterations were inconsequential in the control group (p=0.405).

CONCLUSION: The findings of this study suggest neutral effects of citicoline on level of consciousness and GCS. Through increasing levels of fetuin-A and MGP, citicoline may have protective effects against inflammatory damage and vascular calcification secondary to head trauma.

Key words: Citicoline; GCS; fetuin-A; level of consciousness; matrix Gla protein; traumatic brain injury.

INTRODUCTION

Traumatic brain injury (TBI) is a leading cause of morbidity and mortality.[1] Based on available data, head trauma is the main reason of death due to trauma and the majority of victims are young men.[2-4]

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TBI is classified, based on timing of injury, to primary and secondary forms, and diffuse and focal types according to the extent of damage.[5,6] Secondary (vs. primary) TBI occurs minutes to hours after primary assault, which is preventable and also treatable with hemodynamic or pharmacological strategies. In order to halt vicious cycle of cellular damage, pharmacological therapies has focused on the usage of calcium channel blockers, free radical scavengers, and membrane-restorative agents.[7]

Fetuin-A or α2-Heremans Schmid glycoprotein (AHSG), a circulatory negative acute phase reactant and anti-inflammatory protein, inhibits ectopic precipitation of Ca PO_4 ions, vascular calcification, and inflammatory cytokine production.[8] Fetuin deficiency results in inflammation, vascular calcification, accelerated atherosclerosis, and higher cardiovascular mortality rate in uremic patients.[9,10]

Matrix Gla protein (MGP) is a vitamin K-dependent inhibitor of extracellular matrix calcification. MGP-deficient mice have developed progressive precipitation of hydroxyapatite crystals on arterial walls and died within two months.[11]

Cytidine-5'-diphosphocholine, also known as Citicoline or CDP-choline, an essential intermediate substance for synthesis of phosphatidylcholine and acetylcholine neurotransmitter (Ach), has been suggested to have neuroprotective and neurorestorative effects.[12]

Considering the burden of TBI and importance of halting secondary brain damage following trauma, preventing lifelong disabilities of the victims, and lack of data on effects of citicoline as neuroprotective agent in this condition, this study aimed at investigating effects of citicoline on level of consciousness and GCS in patients with severe head trauma. In order to evaluate impact of citicoline on suppression of inflammation and secondary vascular calcification, fetuin-A and MGP were assessed as quantitative markers of inflammation status and ectopic calcification.

MATERIALS AND METHODS

This double blind randomized controlled trial (RCT) included patients admitted to the trauma department of Emam-Reza Research and Training Hospital affiliated by Tabriz University of Medical Sciences with the diagnosis of diffuse axonal injury (DAI) and GCS≤8 between September 2011 and March 2012.

The inclusion criteria were: age between 18 and 65 years, giving informed written consent by first degree relatives, absence of major traumatic lesion of the chest, abdomen or limbs, absence of focal brain lesions such as contusion or hematoma mandating surgical drainage admission within 24 hours after trauma, absence of heart disease, negative history for cardiovascular diseases, hyperlipidemia, diabetes, and hypertension. The patient was excluded in the case of not having inclusion criteria, pregnancy, surgery (including orthopedic, gynecologic and etc.) within the first 24 hours following trauma, cardiopulmonary resuscitation (CPR) within the first 24 hours after trauma, death or discharge before study completion.

The patients were divided into two groups, case and control, using a randomized parallel-group design and were randomly allocated to the case group receiving citicoline and the control group not receiving the drug.

The diagnosis was made based on CT findings including, single or multiple small intraparenchymal hemorrhages in cerebral hemispheres (<2 cm in diameter), intraventricular hemorrhage, hemorrhage in the corpus callosum, small focal areas of hemorrhage adjacent to the third ventricle (<2 cm in diameter), and brain stem hemorrhage. Written informed consent was taken from first degree family members after explaining the goals and the whole process of the study. The study duration was fifteen days. Patients were randomly assigned to either groups. A thorough physical and neurological examination was done and the acquired GCS score was recorded immediately on admission to the trauma department; A 10 cc blood sample was taken and the samples were investigated for serum levels of fetuin-A and MGP. Citicoline was administered to the case group (500mg every 6 hours) intravenously by a nurse blinded to the study process. For both groups, blood-sampling was repeated on the sixth and twelfth days of admission, re-evaluating serum levels of fetuin-A and MGP. The results were recorded on related forms for each patient by the examiner (resident of neurosurgery), who remained unchanged during the whole study period and was blinded to the grouping of the patients. Meanwhile, the patients were examined by the resident on daily basis and the assessed GCS scores were recorded.

For the purpose of analysis, SPSS (Statistical Package for Social Sciences) version 21 was used. The results were reported as mean ± Standard Deviation (SD). Analysis of variance (ANOVA) was utilized for cohort evaluation of each group. Considering data homogeneity, independent sample T-test was used for comparison between groups; a p value <0.05 considered to be statistically significant.

This research project was conducted after the approval of the Research Ethics Committee of Tabriz University of Medical Sciences.

RESULTS

Fifty-eight patients (13 female and 45 male patients), equally divided into case and control groups, were included into the study. The mean (±standard deviation) age of the patients was 30.94±8.6 years (maximum, 53; minimum, 18). The average GCS scores of the case group revealed statistically significant changes on various days of admission, which was highest on the fifteenth day (p<0.001). Corresponding values for the control group, also, had considerable alterations and were highest on the fifteenth day (p=0.000). Mean GCSs were comparable on each test day (p>0.05) (Table 1). The mean levels of serum fetuin-A for the case group were 45±9.26 ng/ml on admission, 48.80±6.5 ng/ml on the sixth day and 51.73±6.8 ng/ml on the twelfth day of admission, which had notable increment (p=0.012). These values for the control group were 42.39±13.54 ng/ml on admission, 44.10±12.60 ng/ml on the sixth day and 46.76±13.80 on the twelfth day of admission. The variation was not substantial in the control group (p=0.455) (Table 2). The average levels of MGP for the case group were 30.84±20.32 ng/ml on admission, 38.20±21.48 ng/ml on the sixth day and 44.86±21.58 ng/ml on the twelfth day of admission. These values for the control group were 25.95±5.92 ng/ml, 34.82±36.41 ng/ml and 31.11±17.65 ng/ml on admission, the sixth and twelfth days, respectively. The increment in serum levels of MGP was con-

Table 1. Mean (±Standard deviation) Glascow Coma Scale (GCS) scores of the patients within the study period

	On Admission	1st Day	6th Day	12th Day	15th Day	p [Cohort evaluation]
Case	5.80±1.47	6.30±1.12	8.1±2.29	10.10±2.88	10.95±3.21	<0.001
Control	6.40±0.82	6.50±1.0	9±2.20	10.15±3.16	11.55±3.26	=0.000
P value	>0.05	>0.05	>0.05	>0.05	>0.05	

Table 2. Mean (±Standard deviation) serum levels of Fetuin-A (ng/ml)

	On Admission	6th Day	12th Day	p [Cohort evaluation]
Case	45±9.26	48.80±6.5	51.73±6.8	0.012
Control	42.39±13.54	44.10±12.60	46±13.80	0.455
P value	0.29	0.08	0.08	

Table 3. Mean (±Standard deviation) levels of Matrix Gla Protein (MGP) (ng/ml)

	On Admission	6th Day	12th Day	p
Case	30.84±20.32	38±21.48	44.86±21.58	0.046
Control	25.95±15.92	34.82±36.41	31.11±17.65	0.405
P value	0.31	0.66	0.01	

siderable in the case group (p=0.046) while this variance was statistically insignificant for the control (p=0.405) (Table 3). As shown in Tables 2 and 3, both groups were similar regarding serum levels of fetuin-A and MGP.

DISCUSSION

TBI, a leading cause of morbidity and mortality worldwide, has two main mechanisms for primary and secondary damage to the neurons. Instantaneously, after trauma, a series of biochemical reactions get started, final products of which can cause clinical presentations such as intensification of vascular calcification, local macrophage-activity, and ultimately, vascular atherosclerosis.[13]

TBI can make changes in anatomical and functional structures of the brain like considerable brain volume loss and parenchymal degradation secondary to severe head trauma.[14]

Since the nervous tissue doesn't have regenerative ability and the damage persists lifelong, therapeutic approaches have focused on banning secondary nerve damage through extracting free radicals from the region.[15] This is, especially, a matter of concern in patients with severe and critical TBI with GCS≤8 and DAI, since, pre-hospital neurologic deterioration and lower level of consciousness are independent factors of poor prognosis.[16,17]

Severe traumatic brain injury is an isolated predisposing factor for succeeding posttraumatic cerebral infarction (PTCI);[18,19] in this setting, besides acute reperfusion strategies such as thrombolysis or mechanical clot removal, practically all available therapeutic protocols focus on palliation and use of neuroprotective agents for mitigation of secondary damage to the nervous system. Citicoline has been reported to have protective and restorative effects on the central nervous system (CNS) by inducing Na^+/K^+ ATPase activity, decreasing lipid peroxidation, preserving mitochondrial membrane cardiolipin, suppressing phospholipase A_2 activity, improving neuroplasticity and synthesis of neurotransmitters like acetylcholine (Ach) or dopamine.[20-22] The drug has protective impact on cell membrane through accelerating re-synthesis of structural phospholipids, stabilizing the membrane, and attenuating free radical synthesis.[23]

Pre-ischemic administration of citicoline attenuated glutamate and LDH release, banning corticostriatal depletion of high energy phosphates through improving ATP restoration and glutamate uptake, secondary to oxygen-glucose deprivation.[24]

Study on experimental stroke models have revealed increased amount of activated microvessels of the infarct area after 21-24 days of citicoline treatment, compared to the controls,

citicoline had pro-angiogenic and protective effects on human brain microvessel endothelial cells of the infarct region.[25,26]

Citicoline has been proposed to improve cognitive function, increasing cerebral blood flow, especially in conditions with vascular and degenerative etiology such as Alzheimer's disease,[27,28] organic brain syndromes, like autism,[29] decreasing cerebral edema, neuronal loss and cortical contusion.[30] Citicoline has been reported to be as beneficial as methylprednisolone on spinal cord injury model of rats.[31]

Citicoline has dose-dependent protective impacts on extravasation and water content of affected lobe and ipsilateral hippocampus (known to be susceptible to injury) in head trauma patients.[32] The agent reduces post-traumatic hippocampal neuronal death, decreases cortical contusion volume and improves neurological recovery.[33] Serum levels of malondialdehyde (an indicator of oxidative stress) has diminished after fifteen days of citicoline treatment in DAI cases, compared to the controls.[34]

Citicoline improved neurological recovery of severe TBI, especially when administered within 24 hours after trauma,[35] which was not in concordance with our findings. On the basis of our results, mean GCS levels increased considerably in both, case and control groups, temporally ($p<0.001$ and $p=0.000$, respectively) but the difference between groups was insignificant until the fifteenth day of admission ($p=0.27$); According to available data, the difference may reach a considerable amount by extending the treatment period, especially up to twenty-one days.[36]

In a study on patients with mild TBI, the outcome was comparable between citicoline and placebo-treated series.[37]

Role of fetuin-A, a negative acute phase plasma protein, was evaluated in sepsis and endotoxemia. Serum level of fetuin decreased temporally, while increasing the concentration of HMGB1, a late inflammatory mediator of sepsis; fetuin-deficient rats were remarkably susceptible to lethal systemic inflammation. Exogenous administration of fetuin reduced HMGB1 levels considerably.[38] In an experimental model of ischemic stroke, exogenous fetuin-A reduced infarct volume 24 hours after ischemia. Proposed mechanisms were activating Spermine-mediated anti-inflammatory processes, decreasing release of HMBG1 from ischemic tissue, suppressing central microglia and peripheral immune cells, diminishing TNF production from ischemic region, and on the whole attenuating inflammatory response secondary to ischemic insult.[39,40] Macrophage-mediated phagocytosis induction by fetuin may prevent accumulation of HMGB1-containing apoptotic cells which can undergo late-onset necrosis and substance release.[41]

Levels of fetuin, along with other inflammation and acute-phase indicators, can predict outcome in patients with acute coronary syndrome or end stage renal disease (ESRD).[42,43]

In the current study, serum levels of fetuin-A increased in the group treated with citicoline, within the study period, which was statistically significant ($p=0.012$), while these changes were inconsiderable in the controls ($p=0.455$). These findings suggest possible anti-inflammatory (via fetuin-A increment)[44] and protective effects against trauma-related vascular calcification and related morbidity and mortality.[45]

A study on familial mediterranean fever (FMF) has showed down-regulation and inverse correlation of fetuin during attack phases, suggesting possible efficacy of fetuin as an indicator of acute phase and disease activity.[46]

Patients with migraine had lower levels of fetuin in comparison to healthy controls. Considering the role of neurovascular inflammation, in pathophysiology of migraine attacks, lower fetuin-A may have a possible role in this inflammatory process.[47]

Neurogenesis, accompanied with angiogenesis, after TBI and stroke has an important role in restoring motor and cognitive function.[48-51] Angiogenesis, along with vasculogenesis, is seen 3-4 days after ischemic insult or TBI, in injured tissue, as a result of endothelial progenitor cells (EPC) invasion.[52,53]

Angiogenesis, as an inevitable component of calcification, especially of blood vessels, heart valves and skeletal muscles, triggers ectopic calcification process.[54]

Possible underlying mechanisms for angiogenesis-induced calcification are as follows: Firstly, vascular progenitor cells can act as a channel for osteoprogenitor cells invasion. Secondly, endothelium-derived cytokines (such as, BMP-4 and BMP-2) stimulate osteoprogenitors and calcification, as the production of these cytokines are up-regulated during inflammation or mechanical forces.[55,56] Inflammatory response and mechanical stresses can result in calcification in certain settings.[57,58] Thirdly, many angiogenic factors like fibroblast growth factor (FGF) and vascular endothelial growth factor (VEGF) can also induce differentiation and migration of osteoblasts, osteoclasts, and chondrocytes.[59]

As a potent inhibitor of vascular calcification, MGP, synthesized by vascular smooth muscle cells,[60] may have a protective role against ectopic calcification following angiogenesis, especially in patients with chronic kidney disease[41] and β-thalassemia.[61]

Higher levels of MGP are related with lower cardiovascular events or mortality in patients with stable coronary artery disease,[62] mandating more aggressive treatment strategies in patients with specific MGP-genotypes.[63]

In our study, serum levels of MGP increased considerably in the case group ($p=0.046$). These changes were inconsequential for the controls ($p=0.405$). Increased amounts of MGP,

inhibiting calcification process following inflammation, and angiogenesis, can prevent vascular damage in affected cases.[64]

According to our findings, citicoline may have a protective role against inflammation and following vascular calcification in secondary-TBI through increasing fetuin-A and MGP. Due to lack of similar papers, comparing findings of this study with other data was impossible.

Limitations of our study included the small number of the cases followed up for a short (15-day) period. For further elucidation of the effects of citicoline in patients with severe TBI, studies with larger case-series and long-term follow up should be conducted. In this context, Glascow Outcome Scale (GOS) can be used overtime to determine impact of citicoline-treatment on final outcome.

The current study evaluated neuroprotective effects of citicoline in patients with severe TBI using quantitative indicators, while previous researches mostly investigated qualitative factor. To our knowledge, this is the first research on possible effects of citicoline on fetuin-A and MGP and their role against inflammation and ectopic calcification in severe TBI.

Conclusion

On the basis of our findings, citicoline, having neutral effects on levels of consciousness, may have a protective role against inflammation and, following vascular calcification, in secondary-TBI through increasing serum levels of fetuin-A and MGP.

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DENEYSEL ÇALIŞMA - *ÖZET*

Yaygın akson hasarı ve GKS ≤8 olan travma hastalarında sitikolinin bilinçlilik durumu, serum fetuin-A ve matriks Gla-protein (MGP) düzeyleri üzerine etkileri

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AMAÇ: Bir sinir koruyucu ilaç olan sitikolinin fetuin-A ve matriks Gla-protein (MGP) gibi kalsifikasyon modülatörlerini tetikleyerek posttravmatik nörogenez ve anjiyogenez sonrası bilinçlilik düzeyini iyileştirdiği, ikincil beyin hasarını ve ektopik vasküler kalsifikasyonu hafiflettiği ileri sürülmüştür. Bu çalışma ağır travmatik beyin hasarlı hastalarda sitikolinin bilinçlilik, serum fetuin-A ve MGP düzeyleri üzerine etkilerini araştırmayı amaçlamıştır.
GEREÇ VE YÖNTEM: Bu çift-kör randomize kontrollü çalışma (RKÇ) yaygın aksonal hasar tanılı GK skoru ≤8 olan hastalarda yapıldı. Olgular 15 gün sitikolinle (6 saatte bir 500 mg i.v.) tedavi edildi. Hem hastalar hem de kontroller günlük GCS değerlendirmesinden geçti, belli aralarla kan analizleri yapıldı.
BULGULAR: Çalışmaya 58 hasta katıldı. Çalışma dönemi boyunca her iki grupta Glaskov Skala skorları iyileşmiş olduğu gibi gruplar arasındaki farklılık hatırı sayılır derecede değildi ($p>0.05$). Sitikolinle tedavi edilen grupta bir negatif faz reaktanı olan serum fetuin-A düzeyleri artmışken ($p=0.012$), kontrollerde bu değişiklikler anlamlı değildi ($p=0.455$). Bir kalsifikasyon inhibitörü olan serum MGP düzeyleri hastalarda yükselmişti ($p=0.046$). Kontrol grubundaki değişiklikler anlamlı değildi ($p=0.405$).
TARTIŞMA: Bulgularımız sitikolinin bilinçlilik düzeyi ve GKS üzerine nötr etkileri olduğunu düşündürtmektedir. Sitikolin fetuin-A ve MGP düzeylerini yükselterek kafa travmasına bağlı enflamatuvar hasar ve vasküler kalsifikasyona karşı koruyucu etkilere sahip olabilir.
Anahtar sözcükler: Bilinçlilik düzeyi; fetuin-A; GKS; matriks Gla protein; sitikolin; travmatik beyin hasarı.

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ORIGINAL ARTICLE

Bowel and mesenteric injury in blunt trauma: Diagnostic efficiency and importance of experience in using multidetector computed tomography

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ABSTRACT

BACKGROUND: The purpose of this study was to investigate the diagnostic efficiency of multidetector computed tomography (MDCT) in the detection of blunt bowel and mesenteric injuries (BBMI), and the role of different experience levels in using MDCT.

METHODS: This study included a test group of twenty-seven patients with surgically important BBMI in whom the diagnoses were confirmed after surgical intervention (23 men and 4 women; mean age, 40.7±16.2; range, 18-76), and a control group of twenty-one matched patients without BBMI who underwent laparotomy for trauma during the same time period (16 men and 5 women; mean age, 38.9±14.5; range, 20-68) and sixteen-detector computed tomography prior to surgery. Intraoperative findings were compared with MDCT findings.

RESULTS: High accuracy, specificity, and positive predictive values in MDCT findings with respect to intraperitoneal free air, mesenteric air, thickened (>4-5 mm) and defected bowel wall, increased contrast enhancement on bowel wall, and mesenteric hematoma were found among others (p<0.01). Sensitivities and specificities of the diagnosis of BBMI by the resident and staff radiologist was 74% and 71%, and 85% and 100%, respectively.

CONCLUSION: MDCT displays BBMI with high sensitivity and specificity, and can predict the need for surgery. Experience in radiology is an important factor for appropriate interpretation of the MDCT findings.

Key words: Blunt abdominal trauma; bowel injury; multidetector computed tomography.

INTRODUCTION

Blunt bowel and mesenteric injuries (BBMI) are rare injuries with high morbidity and mortality, and occur in only 1-5% of blunt abdominal traumas.[1-4] Accurate diagnosis is of great importance since delayed diagnosis of BBMI may result in serious complications and mortality. Early diagnosis of isolated BBMI is difficult in patients with blunt abdominal trauma as clinically apparent signs and symptoms of peritonitis caused by perforation can be observed only after a considerable period of time, causing delayed diagnosis. As a result of delay in diagnosis, intraabdominal complications, such as abscess, sepsis, and even mortality, can be seen after surgical repair.[5-7] Signs and symptoms of peritonitis like rigidity, tenderness, and rebound are sometimes undetectable, and abdominal examination findings may be obscure in patients critically injured or neurologically compromised or in those experiencing an altered sensorium resulting from drugs, alcohol intoxication, or central nervous system trauma simultaneously. Currently, the diagnostic modalities besides physical examinations are paracentesis, diagnostic peritoneal lavage, focused abdominal sonogram for trauma, computed tomography (CT) scan, and laparoscopy.[7-15] Multidetector computed tomography (MDCT) is an excellent imaging modality for diagnosing and managing patients with abdominal injuries while playing critical role in describing and grading solid-organ injuries, diagnosing the significance of BBMI, and deciding whether surgical

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intervention is required. If patients are hemodynamically unstable, detection of suspected bowel and mesenteric injuries is necessary for emergency surgical treatment.[4-7] However, if patients are hemodynamically stable and no suspicious BBMI is present on MDCT, nonsurgical management is the acceptable standard care for blunt abdominal trauma. However, the true contribution of MDCT in diagnosing BBMI is controversial;[16,17] there is a wide spectrum of signs correlating with the type, site, and extent of damage on CT.[4] Although CT imaging technology and interpretation has improved greatly in the past decade in terms of detection or exclusion of BBMI, controversy still remains as to how reliable MDCT is in distinguishing surgical from nonsurgical bowel and mesenteric injury.[5]

The main goals of this study were to investigate the diagnostic accuracy of MDCT in the detection of bowel and mesenteric injuries, and evaluate the concordance of MDCT findings of BBMI with surgical observations and with different experience levels in radiology.

MATERIALS AND METHODS

The ethics committee of our hospital approved this retrospective case-control study and waived the requirement for informed patient consent.

Patients

Totally, two thousand nine hundred and twenty-three patients with blunt abdominal trauma between January 2007 and December 2012 were enrolled. The test group comprised twenty-seven patients with surgically important BBMI whose diagnoses were confirmed after surgical intervention (23 men and 4 women; mean age, 40.74±16.2 years; age range, 18-76 years). The control group comprised twenty-one matched patients without BBMI who underwent laparotomy for trauma during the same time period (16 men and 5 women; mean age, 38.9±14.5 years; age range, 20-68 years) and sixteen-detector computed tomography prior to surgery. Intraoperative findings were compared with MDCT findings.

MDCT Technique and Interpretation

MDCT scans were obtained using a 16-row multidetector CT scanner (Aquilion 16; Toshiba Medical Systems Corporation, Japan). The scanning parameters were as follows: 150 mAs; 120 kV; collimation, 2x16 mm; pitch, 1; section thickness, 3 mm; reconstruction interval, 1 mm; and tube rotation period, 0.5 s. Intravenous iodinated contrast was given according to protocol: 100-120 ml of 350 mg/ml contrast at 3 ml/s. Oral contrast (OC) was not used routinely due to current controversy on using OC in trauma patients. OC use in trauma patients may sometimes cause cervical restraints, a supine position, intoxication, diminished sensorium, nausea, vomiting, need for a nasogastric tube, risks of aspiration, and time constraints with limited visualization of the intestinal tract[10]; only five patients were administered OC in this study. For single-phase imaging, post-contrast images of the abdomen and pelvis were acquired at 70 s. When necessary, sagittal and coronal images were acquired using the multiplanar reconstruction technique. Scans were also evaluated using the "lung or bone" windows that helped differentiate between abdominal fat and air.

In order to assess the accuracy of different levels of experience on radiology, all CT scans were reevaluated independently by a fourth-year radiology resident and a staff abdominal radiologist, both of whom were blinded to the patients' final outcomes and the initial radiological reports. All evaluations were reviewed using our department's picture archiving and communicating system on liquid crystal display monitors, and the probability of BBMI was recorded. Coronal and sagittal CT reconstructions were available for review, if necessary. Numerous CT signs of bowel and mesenteric injury secondary to blunt trauma have been described in the literature, and our CT findings were based on these descriptions.[17, 18] CT signs of BBMI are intraperitoneal air, retroperitoneal air, mesenteric air, thick bowel wall, abnormal bowel wall enhancement, bowel wall defect, intraperitoneal fluid, retroperitoneal fluid, focal mesenteric hematoma, mesenteric fluid, and mesenteric stranding.

Statistical Analyses

The X^2 test was used for the comparison of categorical variables; the Wilcoxon rank-sum test was used for the comparison of continuous variables. Sensitivity, specificity, and positive and negative predictive values were calculated for each reader and each MDCT sign. For evaluating concordance of the diagnoses of BBMI by the two readers, kappa ratio was calculated for each reader. According to the criteria of Landis and Koch,[19] a kappa value of less than 0 indicated less agreement than expected by chance; 0-0.20, slight agreement; 0.21-0.40, fair agreement; 0.41-0.60, moderate agreement; 0.61-0.80, substantial agreement; 0.81-0.99, almost perfect agreement; and 1.0, perfect agreement. Positive and negative likelihood ratios were calculated for individual MDCT signs. A value of $p<0.05$ was considered to be significant.

RESULTS

Twenty-seven (56%) of 48 patients had surgically proven BBMI and 21 (44%) patients had no BBMI. The BBMI rate detected on MDCT in our study was 0.9% (27/2923). Of the twenty-seven patients with BBMI, 20 (74%) had bowel injury, 3 (11%) had mesenteric injury, and 4 (15%) had bowel and mesenteric injury. The localizations of bowel injury were the ileum, 12 (50%); jejunum, 6 (25%); colon, 3 (13%); jejunum-ileum, 2 (8%); and ileum-colon, 1 (4%). Forty-two (88%) patients had been involved in a motor vehicle accident. Of the remaining six injuries, four resulted from falls and two form industrial accidents. Peritoneal lavage was not performed for

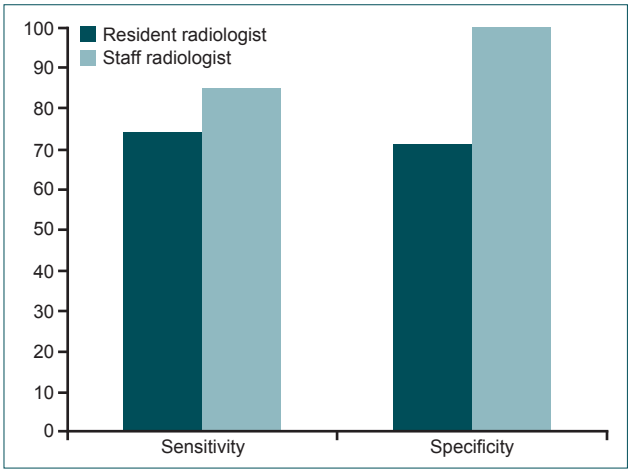

Figure 1. Graph shows diagnostic performance of staff and resident radiologist.

any of the patients. OC was not used routinely; only five patients were given OC in our study.

Sensitivities of the resident and staff radiologist in the diagnosis of bowel and/or mesenteric injury ranged from 74% to 85% and the specificities ranged from 71% to 100%; false-negative case numbers were 9 and 4 and false-positive case numbers were 2 and 0, respectively (Fig. 1).

High accuracy, specificity, and positive predictive values for MDCT findings in terms of intraperitoneal free air, mesenteric air, thickened (>4-5 mm) bowel wall, increased contrast enhancement on bowel wall, bowel wall defect, and mesenteric hematoma were found among others (Table 1). Intraperitoneal free air (Fig. 2a), mesenteric air (Fig. 2b), thick large bowel (Fig. 2c), increased bowel wall enhancement (Fig. 2c), bowel wall defect (Fig. 2d), focal mesenteric hematoma, and mesenteric fluid and mesenteric stranding (Fig. 2e) showed the best positive likelihood ratios for bowel and/or mesenteric injury. MDCT findings, reviewed by the staff radiologist, were given in Table 2 according to the injury type. The differences in detecting BBMI were statistically significant among readers evaluating inter-observer agreement between reviewers ($p<0.01$). In case of the staff radiologist, the concordance of the CT findings and operative findings was excellent (kappa ratio: 0.834 [0.81-1, excellent]).

DISCUSSION

MDCT significantly affects the decision on managing non-operative patients without BBMI but with isolated solid-organ injuries. However, the diagnosis of patients with suspected BBMI after blunt trauma is a dilemma and clinical diagnosis of BBMI and differentiation of those requiring surgery from those that can heal clinically is the main problem.[16,17]

Although CT is the best noninvasive modality presently available to diagnose BBMI, several studies report that only CT is unreliable in diagnosing BBMI.[5,10,17] Sharma et al. reported that BBMI was not initially diagnosed in 35% (8 of 23) of the patients.[10] Bhagvan et al.[17] stated that the false-negative CT scan incidence was 13% in five hundred and fifty-eight patients with small bowel perforation. It is considered necessary to conduct an urgent exploration for any unexplained and nonspecific CT scan findings in patients with more than one suspicious finding for bowel or mesenteric injury on the CT scan due to the possibility of false negativity.[10] In our study, the false-negative rate was 14.8% (4/27) for the staff radiologist and 33.3% (9/27) for the radiology resident. In terms of evaluations of CT findings, in this study, high accuracy, speci-

Table 1. Sensitivity, specificity, and likelihood ratios of various signs in identifying surgically important bowel and/or mesenteric injury

					Likelihood Ratio	
Sign	**Sensitivity (%)**	**Specificity (%)**	**PPV (%)**	**NPV (%)**	**Positive**	**Negative**
Intraperitoneal air	33	100	100	53	Infinity*	0.67
Retroperitoneal air	11	85	50	42	0.73	1.04
Mesenteric air	41	100	100	56	Infinity*	0.59
Thick bowel wall	52	91	87	60	5.7	0.52
Abnormal bowel wall enhancement	52	100	100	62	Infinity*	0.48
Bowel wall defect	26	100	100	51	Infinity*	0.74
Intraperitoneal fluid	81	33	61	58	1.2	0.58
Retroperitoneal fluid	41	42	48	36	0.79	1.4
Focal mesenteric hematoma	19	95	83	48	3.8	0.85
Mesenteric fluid	52	95	93	61	10.4	0.5
Mesenteric stranding	81	76	81	76	3.4	0.25

PPV: Positive predictive value; NPV: Negative predictive value, *: This likelihood ratio is considered useful in clinical practice.

Table 2. Relations of individual CT signs with injury type

Sign	Injury type					
	Bowel injury (n=20)		Mesenteric injury (n=3)		Bowel and mesenteric injury (n=4)	
	n	%	n	%	n	%
Intraperitoneal air	8	40	0	0	1	25
Retroperitoneal air	2	10	0	0	1	25
Mesenteric air	9	45	0	0	2	50
Thick bowel wall	13	65	0	0	1	25
Abnormal bowel wall enhancement	13	65	0	0	1	25
Bowel wall defect	5	25	0	0	2	50
Intraperitoneal fluid	17	85	3	100	2	50
Retroperitoneal fluid	6	30	2	67	3	75
Focal mesenteric hematoma	3	15	2	67	0	0
Mesenteric fluid	13	65	1	33	0	0
Mesenteric stranding	17	85	3	100	2	50

ficity, and positive predictive values in terms of intraperitoneal free air, mesenteric air, bowel wall thickening, and increased contrast enhancement on bowel wall, bowel wall defect, and mesenteric hematoma were found among others.

Besides the difficulty in performing a CT diagnosis, it warrants optimal technique and skilled interpretation. Atri et al. have found that the staff radiologist is significantly more accurate than the resident in identifying mesenteric injuries ($p<0.01$). In case of surgically important bowel injuries, significant differences were observed between the sensitivity and specificity values of the staff radiologist and those of the trainees (resident and fellow).[4] In the present study, the difference in detecting BBMI in terms of sensitivity and specificity were statistically significant between the two readers ($p<0.01$). The concordance of the CT findings with the operative results was excellent in the case of the experienced radiologist (kappa ratio: 0.834).

Several studies report on discrepancies in CT interpretations by residents and staffs. Tieng et al. have reported a 10% discrepancy rate.[20] Yoon et al.[21] have found a 29.9% discrepancy rate in their study. In this study, the false-negative rates were 8.3% (4/48) for the staff radiologist and 18.75% (9/48) for the resident. The staff radiologist had no false-positive rate but the resident had two false positives (4%, 2/48) in our cohort. While our discrepancy rate is moderate at 14.6%

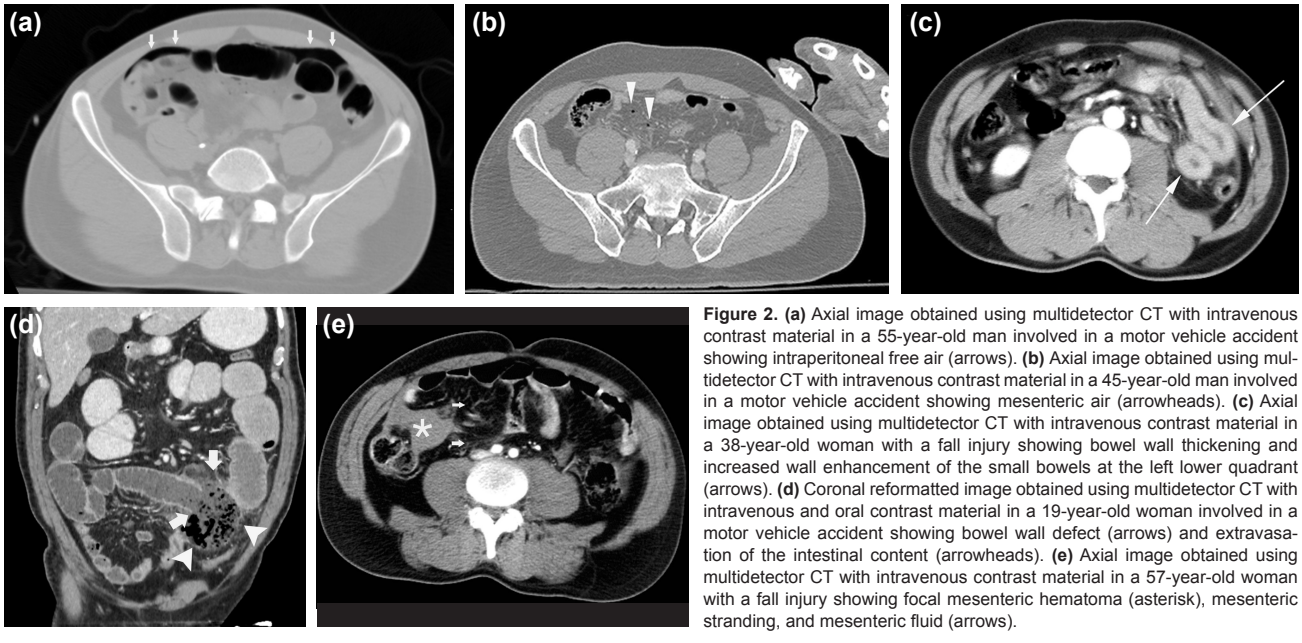

Figure 2. (a) Axial image obtained using multidetector CT with intravenous contrast material in a 55-year-old man involved in a motor vehicle accident showing intraperitoneal free air (arrows). **(b)** Axial image obtained using multidetector CT with intravenous contrast material in a 45-year-old man involved in a motor vehicle accident showing mesenteric air (arrowheads). **(c)** Axial image obtained using multidetector CT with intravenous contrast material in a 38-year-old woman with a fall injury showing bowel wall thickening and increased wall enhancement of the small bowels at the left lower quadrant (arrows). **(d)** Coronal reformatted image obtained using multidetector CT with intravenous and oral contrast material in a 19-year-old woman involved in a motor vehicle accident showing bowel wall defect (arrows) and extravasation of the intestinal content (arrowheads). **(e)** Axial image obtained using multidetector CT with intravenous contrast material in a 57-year-old woman with a fall injury showing focal mesenteric hematoma (asterisk), mesenteric stranding, and mesenteric fluid (arrows).

(7/48), it cannot be guaranteed in the current practice. Even one case is very important and if it were to be concluded, a terrific result would have occurred due to this discrepancy. As in many countries, in our institute, general workflow in terms of daily practice is the interpretation given at night by residents. After this initial resident interpretation, secondary review is performed by a staff radiologist within 24 h. This delay may sometimes cause mortality; teleradiology may be a solution for preventing this kind of time delay and consulting with experts during off-hours.

Teleradiology interpretations may assist emergency physicians in making appropriate medical decisions and radiology residents provide initial readings and prevent discrepancies during off-hours. Teleradiology is defined as the electronic transmission of radiographic images between two geographical locations for the purposes of interpretation and consultation. In countries with picture archiving and communication system (PACS) integrated in a regional or national network, image distribution can be organized in a cross-enterprise fashion. In many European countries and in the United States, a large teleradiology network has been established and the DICOM-email is the accepted standard. In several hospitals, teleradiology has become a part of the regular workflow. Image distribution using PACS support home-based (on call) radiologists in emergency situations.[22,23]

There are several limitations to this study. It was retrospective; patients of a specific period of time were reviewed and only patients with blunt abdominal trauma were evaluated. In addition, the CT finding readers were aware of the patients surgically treated but were blinded for the surgical reports; this might have forced the readers to try to find a pathological finding on the CT scans. However, since the staff and resident were informed of the cases in the same manner, no differences existed in the distribution of information to both readers. Moreover, as the CT findings were compared with operative findings, only surgically treated patients were included into the study. In addition, this study included a small number of surgically proven BBMI cases.

Experience in radiology is an important factor causing differences in the interpretation of CT findings and making CT examination more sensitive and specific in terms of decision-making on the clinical management (surgery or nonsurgical follow-up). Awareness of BBMI findings on CT scans and experience increase the diagnostic accuracy of CT. However, diagnosis of BBMI is difficult and CT cannot be used as the only diagnostic tool. Close clinical observation, monitoring, and surgical expertise are mandatory for appropriate management. Teleradiology may help in reporting cases from out of hospital and may help to avoid discrepancies. Further studies are needed to better define the sensitivity of teleradiological interpretations for identifying the pathology of trauma.

Conflict of interest: None declared.

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KLİNİK ÇALIŞMA - *ÖZET*

Künt travma sonrası bağırsak ve mezenter yaralanmalarında çok kesitli bilgisayarlı tomografinin tanısal etkinliği ve tecrübenin önemi

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AMAÇ: Çalışmamızda künt bağırsak ve mezenter yaralanmalarında (KBMY), çok kesitli bilgisayarlı tomografinin (ÇKBT) tanısal etkinliğinin ve farklı düzeydeki radyolog tecrübesinin tanıya katkısının değerlendirilmesi amaçlandı.
GEREÇ VE YÖNTEM: Çalışma grubuna travma nedeniyle cerrahi uygulanan ve klinik önemli KBMY olduğu doğrulanan ve ameliyat öncesi BT incelemeleri mevcut olan 27 hasta (23 erkek, 4 kadın, ort. yaş 40.77±16.2 yıl; dağılım 18-76 yıl) alındı. Kontrol grubu olarak da yine aynı dönemde BT incelemesi mevcut olan ve cerrahi sonrası KBMY olmadığı doğrulanmış 21 hasta (16 erkek, 5 kadın, ort. yaş 38.9±14.5; dağılım, 20-68) alındı. Cerrahi öncesi 16 kesitli ÇKBT ile yapılan incelemeler ameliyat bilgileri bilinmeksizin tekrar yorumlandı. ÇKBT bulguları ameliyat bulguları ile karşılaştırıldı.
BULGULAR: Çok kesitli bilgisayarlı tomografi bulguları içinde; intraperitoneal serbest hava, mezenterik hava, bağırsak duvarında kalınlaşma (>4-5 mm), bağırsak duvarında kontrastlanma artışı, bağırsak duvarında defekt ve mezenterik hematom bulgusu, doğruluk, özgüllük ve pozitif öngörü değer bakımından yüksek bulundu ($p<0.01$). KBMY doğru tanı koyabilmede kıdemli radyoloji asistanı ve abdomen tecrübeli radyolog arasında duyarlılık ve özgüllük sırasıyla %74, %71 ve %85, %100 bulundu.
TARTIŞMA: Çok kesitli bilgisayarlı tomografi, KBMY'yi yüksek duyarlılık ve özgüllük ile gösterebilir ve cerrahi gerekliliğini öngörebilir. Radyolojideki tecrübe ÇKBT'nin doğru raporlanmasında önemli bir faktördür.
Anahtar sözcükler: Bağırsak yaralanması; çok kesitli bilgisayarli tomografi; künt karın travması.

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ORIGINAL ARTICLE

The clinical value of leucocyte count and neutrophil percentage in diagnosing uncomplicated (simple) appendicitis and predicting complicated appendicitis

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ABSTRACT

BACKGROUND: The aim of this study was to establish the diagnostic value of leucocyte count and neutrophil percentage in both diagnosing simple appendicitis and predicting complicated appendicitis.

METHODS: The patients who underwent appendectomy with a clinical diagnosis of acute appendicitis (AA) between January 2011 and December 2012 were studied retrospectively. The data of total WBC count, neutrophil ratio, and physical findings were analyzed. Sensitivities and specificities of leucocyte count and neutrophil ratio were calculated.

RESULTS: One hundred and fifty-nine patients, diagnosed with acute appendicitis, were operated. Simple appendicitis was detected in 82.4% of the patients and complicated appendicitis in 17.6%. Leucocyte count had low sensitivity and specificity for diagnosing acute appendicitis (67.5% and 36.3%, respectively). Neutrophil ratio had a sensitivity rate of 60.1% and specificity rate of 90.9%. Complicated appendicitis was more common in male patients. Leucocyte count was statistically higher in patients with complicated appendicitis.

CONCLUSION: Two inflammatory markers, leucocyte count and neutrophil ratio, were evaluated for diagnosing acute appendicitis. Neutrophil ratio had higher sensitivity and specificity for acute appendicitis. On the other hand, increased leucocyte count and male gender was found to be a risk factor for complicated appendicitis.

Key words: Appendicitis; leucocyte; neutrophil count.

INTRODUCTION

Appendicitis is the most common acute surgical disease of the abdomen. Patients with acute appendicitis usually present with typical abdominal pain and physical findings include right lower quadrant tenderness, rebound tenderness, and muscle guarding. The clinical diagnosis of acute appendicitis (AA) can be difficult especially in females of child bearing age, children and the elderly. Negative appendectomy rates may reach up to 20 to 30%.[1]

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Complicated acute appendicitis, (perforation, gangrenous appendicitis, intraabdominal abscess, plastron formation and generalized peritonitis) may be detected in 20 to 30% of all appendicitis patients.[2] It is related with increased risk of morbidity and mortality. Complicated appendicitis is associated with increased rate of wound infection, intraabdominal abscess, and postoperative ileus. Due to these serious problems, early diagnosis of appendicitis is mandatory in order to prevent these complications.

The aim of this study was to establish the diagnostic value of leucocyte count and neutrophil percentage in both diagnosing simple appendicitis and predicting complicated appendicitis.

MATERIALS AND METHODS

The patients who underwent appendectomy with a clinical diagnosis of AA between January 2011 and December 2012 were studied retrospectively. The diagnosis of AA was established by medical history, physical examination, white blood cell (WBC) and neutrophil counts, and imaging tests including ultrasonography and abdominal computed tomography.

Table 1. Demographic characteristics of the patients

	Group I (Negative appendectomy) n=11	Group II (Uncomplicated AA) n=122	Group III (Complicated AA) n=26
Age	22.55±8.88 (8-37)	21.26±10.25 (4-53)	25.42±13.72 (9-57)
Gender (Male/Female)	8/3	72/50	21/5
Nausea	7	60	14
Vomiting	5	49	9
Fever	0	10	4
Tenderness in right lower quadrant	11	121	26

Blood samples were obtained from the patients at the time of admission. Demographic findings, symptoms, signs, WBC and neutrophil counts, surgical procedures, and histopathological results of the appendix examination were recorded. According to the results of histopathological examination of the appendix, patients were divided into 3 groups including Group 1 with normal appendix (negative appendectomy); Group 2 with uncomplicated inflamed appendicitis (catarrhal and phlegmonous appendicitis); and Group 3 with complicated appendicitis (perforated and gangrenous appendicitis, plastron formation). A positive WBC count was taken as being >10000 cells/mm^3. Neutrophil ratio >70% was accepted as abnormal. Analysis of the data of total WBC count, neutrophil ratio, and physical findings (rebound tenderness and muscle guarding) was performed. Sensitivities, specificities, positive and negative predictive values of leucocyte count, and neutrophil ratio were calculated.

SPSS 17.0 statistical program was used for statistical analysis. The groups were compared using t test for continuous variables and chi-square test for categorical variables. Mann-Whitney U test was used to compare nonhomogeneous groups in pairs. P value <0.05 was considered statistically significant.

RESULTS

There were one hundred and fifty-nine patients operated with the diagnosis of acute appendicitis in this study. There were one hundred and one male and 58 female patients. The demographic features of all patients were shown in Table 1.

Simple appendicitis was detected in 82.4% of the patients and complicated appendicitis in 17.6% of all patients with acute appendicitis. Leucocyte count had low sensitivity and lower specificity values for diagnosing acute appendicitis (67.5 % and 36.3%, respectively). On the other hand, neutrophil ratio had a sensitivity rate of 60.1% and specificity rate of 90.9% (Table 2).

There were no age differences between Groups 2 and 3. Complicated appendicitis was more common in male patients, which was statistically meaningful (p<0.05) (Table 3).

Table 2. The sensitivity, specificity, positive and negative predictive values of WBC count and neutrophil ratio in diagnosing acute appendicitis

	WBC count	Neutrophil ratio
Sensitivity	67.5%	60.1%
Specificity	36.3%	90.9%
Positive predictive value	0.93	0.97
Negative predictive value	0.07	0.14

WBC: White blood cell.

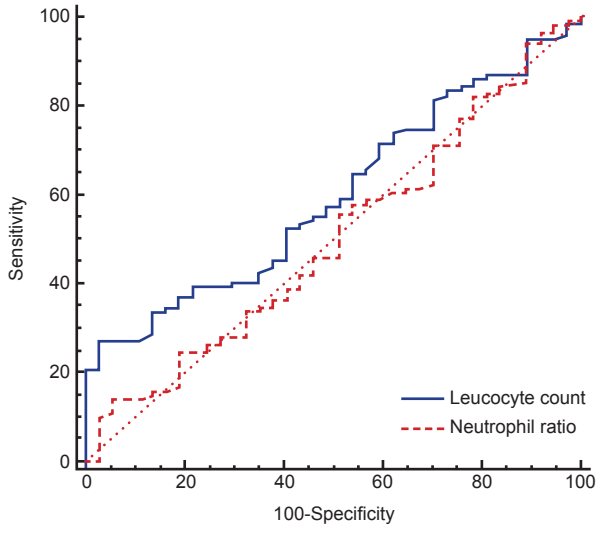
Table 3. Gender distribution in two groups

	Patients				p
	Simple appendicitis		Complicated appendicitis		
	n	%	n	%	
Gender					
Female	50	90.9	5	9.1	0.028
Male	72	77.4	21	22.6	
Total	122	82.4	26	17.6	

Table 4. Comparison of two groups according to age, leucocyte, and neutrophil count

	Patients				p
	Simple appendicitis		Complicated appendicitis		
	Mean	SD	Mean	SD	
Age	21.36	10.25	25.42	13.72	0.338
Leucocyte	12.257,30	4.609,25	14.644,62	4.110,15	0.016
Neutrophil	73.56	13.28	76.32	17.39	0.147

SD: Standard deviation.



Pairwise comparison of ROC curves	
Leucocyte-Neutrophil	
Difference between areas	0.0957
Standard Error	0.0431
95% Confidence Interval	0.0112 to 0.180
z statistic	2.221
Significance level	p=0.0264

	AUC	SE	95% CI
Leucocyte	0.596	0.0493	0.515 to 0.673
Neutrophil	0.500	0.0544	0.420 to 0.580

Figure 1. ROC curves for leucocyte count and neutrophil ratio.

Leucocyte count was statistically higher in patients with complicated appendicitis ($p<0.05$). Although neutrophil ratio was higher in complicated appendicitis, the difference was not statistically significant ($p>0.05$) (Table 4). ROC curves for leucocyte count and neutrophil ratio were shown in Figure 1. AUC value was 0.596 for leucocyte count and 0.500 for neutrophil ratio. Leucocyte count was found to be a better predictive test for diagnosing acute appendicitis.

DISCUSSION

Acute appendicitis (AA) is a common surgical problem. About 7.0% of the general population suffers from appendicitis during their lifetime. It is most commonly encountered in young adults. The diagnosis of acute appendicitis is still a problem even in this modern era. The combination of history, physical examination, laboratory tests, and imaging studies are used for an accurate diagnosis. Several diagnostic tests are used for appendicitis including leucocyte count, neutrophil percentage, C-reactive protein (CRP), D-Dimer, and Procalcitonin. [3-6] However, today, there is no single laboratory test or imaging modality for diagnosing acute appendicitis with 100% sensitivity.

Leucocyte count is the most frequently used laboratory test in diagnosing appendicitis. It is found easily in every medical center. Moderate leukocytosis (15.000/mm^3) is usually the earliest event in the inflammation of the appendix. Leukocyte counts higher than 18.000/mm^3 can be related with complicated appendicitis. In several clinical reports, the range of sensitivity and specificity of WBC in the diagnosis of AA have been reported to be 67%- 97.8% and 31.9%-80%, respectively.[7] In this study, both sensitivity and specificity of leucocyte count was found low for the diagnosis of acute appendicitis, being 67.5% and 36.3%, respectively. The very low ratio of specificity may be explained by small sample size of the negative appendectomy group.

Neutrophil ratio was also used as a laboratory test for acute appendicitis. In a retrospective study, elevated neutrophil ratio has been detected as a good diagnostic marker in acute appendicitis. The sensitivity of neutrophil ratio has been 60.1% and specificity 76.9% in diagnosing acute appendicitis.[8] In the present study, the sensitivity and specificity of neutrophil ratio was found 60.1% and 90.9%, respectively. According to these results, neutrophil ratio seems to be a better inflammatory marker in acute appendicitis.

Some reports have argued that neutrophil ratio is related with appendicular necrosis and perforation. A neutrophil ratio above 85% has been associated with advanced appendicular inflammation.[9-11] There was no statistically significant difference in the neutrophil ratio between simple and complicated appendicitis in this study. Therefore, neutrophil ratio was not a proper laboratory test to predict complicated appendicitis.

Al-Gaithy et al.[12] have studied four hundred and fifty-six patients with appendicitis while trying to determine the diagnostic value of leucocyte count and neutrophil ratio and the relation of these inflammatory markers with the severity of acute appendicitis. They have stated that leukocyte and neutrophil counts cannot be used as single diagnostic tests for acute appendicitis. These markers have low sensitivity and specificity. Leucocyte and neutrophil counts do not show the severity of appendicular inflammation, as well. Xharra et al.[13] have compared the diagnostic value of CRP, WBC and neutrophil count in acute appendicitis. They have reported that the diagnostic value of CRP is not significantly greater than that of WBC and neutrophil and CRP level is directly related to the severity of acute appendicitis. Shafi et al.[14] have studied leucocyte count, neutrophil ratio and CRP level in acute appendicitis. They have indicated that measuring these markers together can increase their specificity and positive predictive value in diagnosing appendicitis.

Complicated appendicitis is associated with perforation, gangrene and intraabdominal abscess formation. The main event to occur in complicated appendicitis is the perforation of the appendix. Thus, the risk factors for appendicular perforation should be reviewed. Barreto SG has studied five hundred and six patients undergoing appendectomy for risk factors causing perforated appendicitis and found that male and old patients over the age of 60 are at significantly increased risk of develop-

ing perforated appendicitis and a delay in admission to hospital is a second risk factor.[15] Patients presenting after the second day of onset of their symptoms were found to be at significantly increased risk for perforation. Leucocyte count had no statistically significant role for perforated appendicitis. On the other hand, neutrophil count was related with the probability of perforation. CRP levels were also detected as an important marker associated with perforation. Complicated appendicitis rate was higher in male patients in our study. The difference was statistically significant. Leucocyte count was found another parameter associated with complicated appendicitis.

In conclusion, two inflammatory markers, leucocyte count and neutrophil ratio, were evaluated for the diagnosis of acute appendicitis. Neutrophil ratio had higher sensitivity and specificity for acute appendicitis. On the other hand, increased leucocyte count and male gender was found to be a risk factor for complicated appendicitis.

Conflict of interest: None declared.

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KLİNİK ÇALIŞMA - *ÖZET*

Lökosit sayısı ve nötrofil oranlarının non-komplike apandisit tanısında ve komplike apandisitlerin belirlenmesinde klinik önemi

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AMAÇ: Bu çalışmanın amacı komplike olmayan apandisitlerin tanısında ve komplike apandisitlerin belirlenmesinde lökosit sayısı ve nötrofil oranının tanısal değerlerini belirlemektir.

GEREÇ VE YÖNTEM: Bu çalışmada Ocak 2011 ile Aralık 2012 tarihleri arasında akut apandisit tanısıyla apandektomi yapılmış olan hastalar geriye dönük olarak değerlendirildi. Lökosit sayıları, nötrofil yüzdeleri ve fiziksel inceleme bulguları değerlendirildi. Lökosit sayılarının ve nötrofil oranlarının duyarlılık ve özgüllükleri hesaplandı.

BULGULAR: Akut apandisit tanısıyla 159 hasta ameliyat edilmiştir. Hastaların %82.4'ünde komplike olmayan, %17.6'sında komplike apandisit tespit edilmiştir. Lökosit sayısının apandisit tanısında düşük duyarlılık ve özgüllüğünün olduğu görüldü (sırasıyla %67.5 ve %36.3). Nötrofil oranının duyarlılığı %60.1, özgüllüğü ise %90.9 olarak bulundu. Komplike apandisit erkeklerde daha sık görülmektedir. Lökosit sayısı komplike apandisitli hastalarda istatistiksel olarak anlamlı yüksek bulundu.

TARTIŞMA: Akut apandisit tanısında lökosit sayıları ve nötrofil oranları değerlendirilmiştir. Nötrofil oranının daha yüksek duyarlılık ve özgüllüğe sahip olduğu görülmüştür. Aynı zamanda erkek cinsiyetin ve lökosit sayısındaki yüksekliğin komplike apandisit açısından birer risk faktörü olduğu görülmüştür.

Anahtar sözcükler: Apandisit; lökosit; nötrofil.

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ORIGINAL ARTICLE

Penile fasciocutaneous flap urethroplasty in long segment urethral stricture

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ABSTRACT

BACKGROUND: The aim of this study was to evaluate the succes of penil fasciocutaneous flap urethroplasty in the treatment of long segment urethral stricture.

METHODS: In this study, seventeen patients with long segment urethral stricture were included. In regard to the length of the narrow segment, vertical or circular penile skin fasciocutaneous flap was anastomosed on 18 F urethral catheter. In the first week and 6th month after removal of the urethral catheter, patients were controlled by uroflowmetry and postvoiding residual urine volume measurement by ultrasound.

RESULTS: The mean age of the patients was 52 (range: 17 to 67 years). The mean follow up-time was 60 months (range: 12-96 months). Mean length of stricture was 105 mm (range: 40-150 mm). Vertical and circular penile fasciocutaneous flaps were used in four and 13 patients, respectively. Maximum urine flow rate and postvoiding residual urine assessment in the first week after removal of the urethral catheter were 19.1 ml/s (range: 9 to 31 ml/s) and 12.9 cm^3 (range: 0 to 40 cm^3), respectively. Same parameters in the postoperative 6th month were 17.4 ml/s (range; 8 to 25 ml/s) and 15.2 cm^3 (range; 0 to 40 cm^3), respectively.

CONCLUSION: Our long term results revealed that penile fasciocutaneous flap urethroplasty method seemed to be a reasonable treatment option in the treatment of long segment urethral stricture.

Key words: Penil fasciocutaneous flap; success; treatment; urethroplasty.

INTRODUCTION

In recent years, endoscopic procedures with high technologies have occupied our daily urology practice. Urethroplasty is one of the last procedures to perform as an open surgery. Although most common etiologies for urethral stricture are blunt or sharp perineal trauma, urethral catheterization, urethral endoscopic procedures, lichen sclerosis, and sexually transmitted diseases, no exact cause can be found in some cases with urethral stricture.[1]

In selecting a treatment method for urethral strictures, the key points to consider are stricture length, location of stricture, and surgeon's preference and experience. Therefore, there is not a single, perfect technique for all patients with urethral stricture. There are many methods used for the treatment of urethral stricture including simple bougie dilatation, visual optic internal urethrotomy, laser urethrotomy, stent placement, balloon dilatation, endoscopic urethroplasty, primary anastomotic urethroplasty, and substitution urethroplasty with flaps and grafts.[2,3]

The treatment of long segment urethral strictures is a very challenging problem for urologists and patients as dilatation and visual urethrotomies do not provide long term success for these cases in general. Substitution urethroplasty with flaps or grafts will be the preferred treatment in these patients. However, there is no agreement in the selection of a flap or graft technique and in the ideal material of a flap or graft. There are many tissues including preputial and penile skin, scrotal skin, dermis, buccal and bladder mucosa, tunica vaginalis, deep fascia, peritoneum, small intestinal submucosa, appendix mucosa, and autologus vein proposed for urethral substitution.[4,5]

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In the current study, long term results of the patients who underwent penil fasciocutaneous flap urethroplasty due to long segment urethral stricture were presented.

MATERIALS AND METHODS

A total of seventeen consecutive male patients with long segment urethral strictures admitted to our department between February 2005 and November 2012 were included in this study. At the time of admission, three patients had cystostomy and 14 had difficult urination. After taking detailed patient history, a careful physical examination involving genital, perineal and rectal regions was performed. Urine analysis, urine culture, and serum biochemical analysis including renal function tests were carried out. In patients without cystostomy, urine flow rate and postvoiding residual urine volume were measured. In order to detect the length and location of urethral stricture, retrograde urethrography using 1/3 diluted contrast material (30 cc saline and 10 cc Telebrix® [Guerbet Inc.]) was practiced in anterior-posterior and oblique positions. In patients with cystostomy, the bladder was filled with same amount of contrast material, the patients were asked to void and cystography was performed in order to detect proximal part of the stricture more clearly. If pyuria was found in urine analysis, urine culture was performed to isolate the responsible agent for the urinary tract infection. If no bacteria was isolated in urine culture in those patients, parenteral 3rd generation cephalosporin was given for 3 days before surgery. If any bacteria was isolated in the culture, appropiate antibiotic therapy was given for at least 7 days. When control urine culture was negative, the patients underwent surgey.

Surgical Technique

Supine position was used when the urethral stricture was located in penile urethra. Dorsal lithotomy position was used if urethral stricture involved in the bulbar urethra. After appropiate positioning, lower abdominal, genital and perineal areas were scrubbed with povidion iodine for five minutes. After putting a traction suture in glans penis, strictured part of the urethra was opened until healthy urethral tissue (Fig. 1a). According to the length and location of the urethral stricture, ventral or circular penil fasciocutaneous flap was prepared (Figs. 1b and c). Width of the penil fasciocutaneous flap was between 15-20 mm with regard to urethral plate available. New urethra was created over 18 F urethral foley catheter with 5/0 Polydiaxanone sture under x2.5 magnification without tension (Fig. 1d). Anastomotic area was covered by surrounding soft tissue. After careful hemostasis to avoid hematoma formation after surgery, a multilayer close was

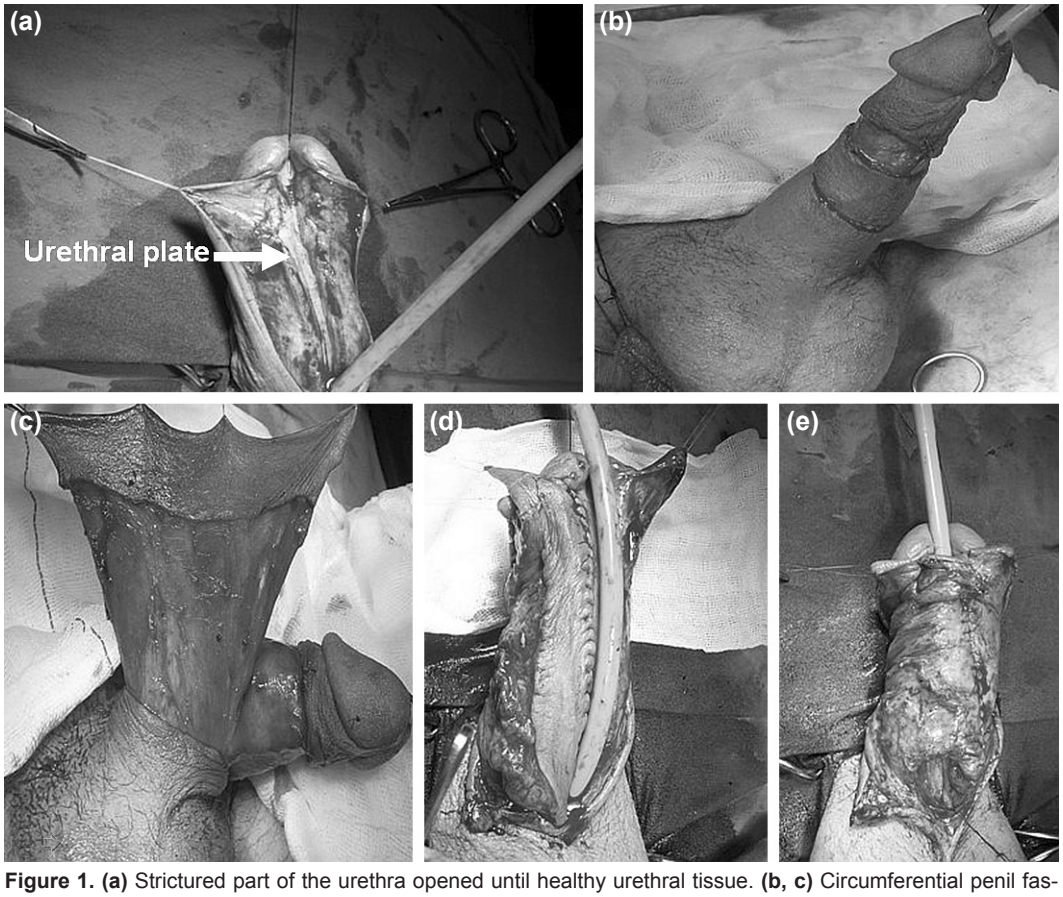

Figure 1. (a) Strictured part of the urethra opened until healthy urethral tissue. **(b, c)** Circumferential penil fasciocutaneous flap preparation. **(d)** Anastomotic urethroplasty with penil fasciocutaneous flap and urethra. **(e)** Anastomotic area is covered by surrounding soft tissue.

performed (Fig. 1e). All operations were performed by one of the authors (A.A.).

Antibiotic treatment was given for 7 days in the postoperative period. Urethral foley catheter was left in place for 21 days. In the first week and 6th month after removal of the urethral catheter, all patients were controlled using uroflowmetry and postvoiding residual urine volume measurement by ultrasound. International Prostate Symptom Score (IPSS) was asked for the patients in the postoperative 6th month. The patients were controlled in each 6 months by same parameters. In patients with troubles in voiding, low urine rate less than 10 ml/s, and postvoiding residual urine above 100 ml, retrograde urethrography and urethroscopy were performed.

RESULTS

The mean age of the patients was 52 (range: 17 to 67 years). Etiologic factors were pelvic bone fracture trauma in five (29.4%), traumatic urethral catheterization in 4 (23.6%), and urethral endoscopic surgery in 3 patients (17.6%). No exact etiology was found in five of the patients (29.4%). All patients were primarily operated and fourteen had previously undergone internal urethrotomies. In four patients with penile urethral stricture, surgery was performed in supine position; whereas in 13 patients with penile and bulbar urethra stricture, surgery was performed in dorsal lithotomy position.

The mean follow up-time was 60 months (12-96). The mean length of stricture was 105 mm (range: 40 to 150 mm). Vertical and circular penile fasciocutaneous flaps were used in four and 13 patients, respectively. Mean operation time was 172 min (range: 90 to 140 min). The mean maximum urine flow rate and postvoiding residual urine volume performed in the first week after removal of the urethral catheter were 19.1 ml/s (range: 9 to 31 ml/s) and 12.9 cm^3 (range: 0 to 40 cm3), respectively. Same parameters mentioned above in the postoperative 6th month were 17.4 ml/s (range: 8 to 25 ml/s) and 15.2 cm^3 (range: 0 to 40 cm^3), respectively. The mean IPSS performed in the 6th month after postoperative removal of the urethral catheter was 6.6 (range: 0 to 15).

No urinary tract and wound infections were seen in the postoperative period. In addition, urethrocutaneous fistula and wound dehiscence were not observed. Penile torsion and penile curvature did not occur in all patients.

In the long term period, stricture at anastomosis region was seen in three (17.6%) patients. Stricture at anastomosis region in these patients occured in first 2 years. Internal urethrotomy was performed in two of the patients. Second look internal urethrotomy was necessary in one of them. The remaining one patient underwent re-urethroplasty. Those three patients have no difficulties in voiding now. In last control, all of the patients including those 3 patients have no difficulties in voiding now.

DISCUSSION

Substitution urethroplasty with flap and graft is performed by two methods: circumferential and patch substitution. While circumferential substitution performed by a tubularised flap or graft over a foley catheter has a low succes rate, patch substitution performed by an onlay/inlay flap or graft placement has a high success rate.[6] Comparing graft and flap methods, both have the same success rates.[6-8] Flap and graft could be placed in dorsal or ventral side of the urethra. In a meta-analysis, success rates of ventral and dorsal replacement have been found the same (87.6% *vs.* 89.2%).[9] Penile skin, prepitium and skrotal skin can be preperad as a flap.[10] There are some important points in performing flap urethroplasty. Surgery should be performed with delicate surgical equipments using absorbable, fine suture material under magnification to avoid tissue trauma and impairment of blood supply in a well-lightened operation room. Suture lines should not be overlapped. Flap pedicle should have enough length in order not to create tension on suture lines. In order to avoid fistula formation and sacculation, a multilayer close should be performed. Hairless areas of the penile skin should be chosen for new urethra. The procedure should be completed in one stage.[10] The advantages of penile fasciocutaneous flap urethroplasty are numerous, which include using well vascularized, hairless and flexible penile skin in repairement a long urethral segment up to 150 mm, transfering easily to all parts of the urethra, being not costly, providing satisfactory results cosmetically, not destroying sexual functions, providing single stage repairement, and being suitable in some of previously circumcised men.[11-13] While preparing penile fasciocutaneous flap, Buck fascia is usually kept to protect neurovascular structures under the Buck fascia. Flap pedicle delicately dissected to protect vascular supply of the flap should be mobilised sufficiently to transfer the flap to proximal part of the urethra and avoid penile torsion. In circular penile skin fasciocutanous flap urethroplasy, which is well described by McAninch and Morey, penile skin is cut from the ventral part.[11] In our patients, we preferred cutting the skin from the dorsal part, feeling that the flap was brought to the bulbar uretral area form the middle of the scrotum more easily.

Several studies have reported that the width of the flap may be changed from 15 to 25 mm according to the width of the urethral plate.[14-18] Width of the flap more than 25 mm should not be used due to increased risk of urethral sacculation and diverticulum formation.[17] Hence, a skin flap wider than 20 mm was not used. Urethral catheter, 16-18 F in size, was left in place between 14 and 21 days.[14,15,17,18] Some authors prefer using cystostomy catheter with urethral catheter.[15-17] In our patients, cystostomy catheter was never necessary. Only 18 F urethral catheter was used for 21 days.

In a study,[15] penile skin flap urethroplasty (n=19) was compared to penile skin graft (n=18) urethroplasty. The mean length of urethral stricture was 141 mm in flap group and

152 mm in graft group. The mean follow up time was 37.1 and 36.2 months in flap and graft groups, respectively. In flap and graft groups, urethral stricture reccurrence was 21% and 27.7%, respectively. The authors concluded that there was no difference between flap and graft urethroplasty methods in terms of success rate. In a study by Whitson et al.,[19] success rates of flap urethroplasty in the 5th and 10th years have been reported to be 84% and 79%, respectively. In a recent study[14] including thirty-six patients who underwent circular fasciocutanaous flap urethroplasty, the mean length of stricture was 60 mm. The flap was placed in the ventral part of the urethra. The mean follow-up time was 96.7 months. According to the study, if patients had no urination problems with good voiding, surgery was considered successful. According to these criteria, success rate was over 90%. Criteria for the failure of surgery were to re-start lower urinary tract symptoms, decrease urine flow rate, and re-stricture seen in urethrography. In the present study, the mean follow-up time was 60 months. The surgery of three patients in our study was a failure due to stricture recurrence. Single internal urethrotomy was sufficient in one patient and the other one patient required a second look internal urethrotomy. The remaining patient underwent re-urethroplasty. Our success rate is believed to be consistent with the international literature.

Penile/preputial island flap urethroplasty provides well-vascularised, versatile, and reliable tissue for urethral substitution. It ensures one-stage repair of strictures of the penile urethra with hairless tissue and maintains its pliability well with little postoperative constriction. Therefore, penile skin flap urethroplasty does not cause any penile shortness or curvarture. After wound healing, penile appearence is cosmetically satisfactory. The penile skin can transfer anywhere from the external meatus to the prostatic urethra for urethral reconstruction as a patch or tube.[13] If the flap falls short, then it can be combined with other tissue transfer techniques, thus enabling one-stage reconstruction in majority of cases.[12] Conversely, Andrich and Mundy have stated that the most reliable technique for long bulbar strictures is a patch augmentation with buccal mucosal graft, which may restore the narrowed urethral calibre to normal.[20] In our patients, penil fasciocutaneous flap urethroplasy was preferred in patients with long segment urethral stricture. Our results are regarded to be very encouraging.

Contraindications of penile fasciocutaneous flap urethroplasty are insufficient penile skin and balanitis xerotica obliterans of the penis.[14,15] In these patients, other tissues should be considered for reconstruction. In general, the complication rate of this surgery is reported between 8% and 20%. Most common complications are scrotal and penile odemea, wound infection, urethrocutaneous fistula formation, stricture reccurrence, skin necrosis, penile torsion, postvoiding dribbling, urethral sacculation, and diveticulum formation.[14-16] A recent prospective study by Olajide et al.[5] was carried out with fifty-five patients with complex anterior urethral stricture to study complications of transverse distal penile island flap urethroplasty in a 6-year-period. The authors reported that infective complications were the commonest complication in their patients including wound infection in 9.1%, urosepsis in 3.6%, and epididymo-orchitis in 1.8% of the patients. In the present study, three (17.6%) of the patients had re-stricture in anastomosis region. Apart from these complications, we did not confront wound infection, urethrocutaneous fistula, skin necrosis, penile torsion, postvoiding dribbling, urethral sacculation, and diverticulum formation.

Our long term results showed that penile fasciocutaneous flap urethroplasty seemed to be a reasonable treatment option in treatment of long segment urethral stricture with acceptable complication rate.

Conflict of interest: None declared.

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KLİNİK ÇALIŞMA - *ÖZET*

Uzun segment üretral darlıklarda penil fasiyokutanöz flep üretroplasti

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AMAÇ: Uzun segment üretral darlıklarda penil fasyokutanöz flep üretroplastinin başarısını incelemek.
GEREÇ VE YÖNTEM: Çalışmamıza uzun segment üretral darlığı olan 17 hasta alındı. Darlık segmentinin uzunluğuna göre, vertikal veya sirküler penil deri fasyokutanöz flep, 18 F üretral kateter üzerinden anastomoz edildi. Hastalar, üretral kateterin alınmasının ardından birinci haftada ve altıncı ayda üroflovmetri ve ultrasonografi eşliğinde yapılan işeme sonrası rezidüel idrar hacmi ölçümleri ile değerlendirildi.
BULGULAR: Hastaların ortalama yaşı 52 (17-67) yıl, ortalama takip süresi 60 (12-96) ay idi. Ortalama darlık uzunluğu 105 (40-150) mm olarak saptandı. Vertikal ve sirküler penil fasyokutanöz flepler sırası ile dört ve 13 hasta için kullanıldı. Üretral kateterin alınmasının ardından birinci haftada yapılan maksimum idrar akım hızı ve işeme sonrası rezidüel idrar ölçümleri sırası ile 19.1 (9-31) ml/sn ve 12.9 (0 - 40) cm^3 idi. Aynı parametreler ameliyat sonrası altıncı ayda 17.4 (8-25) ve 15.2 (0-40) olarak ölçüldü.
TARTIŞMA: Uzun dönem sonuçlarımız penil fasyokutanöz flep üretroplastinin uzun segment üretral darlıklarda uygun bir tedavi seçeneği olduğunu göstermektedir.
Anahtar sözcükler: Üretroplasti; penil fasiyokutanöz flep; tedavi; başarı.

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ORIGINAL ARTICLE

The role of headache management in minor head injury before performing brain CT scan - can intravenous morphine sulfate predict intracranial injury?

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ABSTRACT

BACKGROUND: The aim of this study was to examine the association between the responses of headache to IV morphine and the findings of brain CT scan in minor head injury (MHI), and to propose a new risk indicator to identify patients requiring CT scanning.

METHODS: A total of 1857 MHI patients ≥15 years of age, presenting with headache and a GCS score of 14 or 15 were included in the study. Intravenous morphine sulfate was administered, and thereafter, patients were assessed for the relief or persistence of headache. Subsequently, a brain CT scan was obtained from all patients.

RESULTS: Patients were divided into two age groups: 15-60 and >60 years. There was a significant association between the response of headache to morphine and the result of brain CT in both age groups ($p<0.001$). In patients aged between 15 and 60, none whose headache had responded to morphine showed any abnormal findings in CT scan (sensitivity=100%). In the >60 group, sensitivity was 58.3% for abnormal CT and 71.4% for neurosurgical intervention.

CONCLUSION: This study suggests that a headache not relieved by morphine is a risk indicator for intracranial injury. This protocol can be used in rural areas with limited access to CT scan as an adjunct to the existing criteria for selecting patients with MHI for CT scanning.

Key words: Brain injuries; computed tomography; craniocerebral trauma; headache; morphine; pain management.

INTRODUCTION

More than 1.5 million people sustain traumatic brain injury in the United States annually.[1] Minor head injuries (MHI) account for a majority of cases in head trauma.[2] The term "minor head injury" is used with variable definitions. It is typically defined as history of blunt head trauma in a patient presenting with Glasgow Coma Scale (GCS) score of 13-15. Some authors include post-traumatic disorientation, loss of consciousness and/or amnesia for the traumatic event in the definition, classifying patients without mentioned alteration in mental status into another category: minimal head injury.[3] Some others exclude patients with the GCS score of 13 from the mild category due to higher incidence of intracranial lesions requiring surgical operations.[4]

The decision of which patients with MHI should undergo computed tomography (CT) evaluation has long been a subject of controversy.[5] On the one hand, incidence of intracranial lesions, especially those clinically significant and more specifically those requiring operative intervention is relatively low in MHI (less than 10% and less than 1%, respectively).[6] Thus, failure to detect clinically insignificant intracranial

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lesions seems to be an acceptable risk of selecting patients for CT scanning.[3] For instance, it has been shown that the presence of isolated contusion in CT images of patients with MHI without any other space occupying lesions does not worsen the short term prognosis and does not increase the need for neurosurgical operations.[7] Moreover, precluding unnecessary CT scanning can significantly reduce health care expenditure[6] and resource use, as well as minimizing radiation exposure,[8] saving time, and preventing unnecessary transfer from centers that CT scan is not available.[9] On the other hand, there is an opposing opinion promoting a more liberal use of CT scan considering the unfavorable outcomes of missing an abnormality. The former is more dominant in a context that health policies emphasize on cost-effective use of resources or where resources are scarce and CT is not extensively available, whereas the latter is favored in a context that the fear of litigation is high.[5] Several studies have assessed different indicators predicting abnormal CT scan,[10-18] and different criteria and guidelines have been developed for judicious utilization of CT scan aiming to reduce the number of unnecessary scans and at the same time not to jeopardize optimal patient care.[3,4,6,9,19-21] The Canadian CT Head Rule (CCHR)[3] and the New Orleans Criteria (NOC)[6] are among the most widely studied decision rules.[8,22-27]

Headache is a very prevalent symptom in the victims of MHI.[28,29] There is no consensus if headache is a reliable indicator of intracranial injury in these patients.[10] It is considered a risk indicator in the criteria developed by Miller et al.[19] and Haydel et al. (NOC);[6] however, not in the CCHR.[3] A clinical policy established by a multidisciplinary panel recommends considering brain CT scan in MHI patients with a GCS score of 15 and no history of loss of consciousness/amnesia if they have severe headache.[4] However, according to a systematic review and meta-analysis carried out by Pandor et al., headache is not a reliable predictor of intracranial injury in adults.[11] Headache is a major contributor to post concussive syndrome and long term disability after mild traumatic brain injury, and early utilization of analgesics might affect the long term outcome. However, the pain is usually undertreated in emergency departments. Paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) are among the most widely used analgesics in mild traumatic brain injury, followed by opiates.[30] The effect of morphine in the management of pain in trauma patients, particularly limb trauma is well-established.[31] The association between the response of headache to IV morphine and the results of brain CT scan in MHI was aimed to be examined, speculating that a headache not relieved by morphine is more likely to be associated with a structural damage that can be observed in the CT scan. The ultimate goal of this study was to propose a new protocol in the selection of patients for CT scanning, particularly to reduce the costly and time-consuming process of patient transfer in rural areas of developing countries, where CT scan and neurosurgery experts are not easily accessible.

MATERIALS AND METHODS

This prospective study was conducted between April 2010 and July 2013 in three major teaching hospitals, each with more than 70.000 annual visits to the emergency department (ED). Patients aged 15 years or older who had sustained blunt head trauma and presented to the ED with headache and a GCS score of 14 or 15 were considered eligible. Patients with any of the following criteria were excluded: focal neurological deficit, suspected open or depressed skull fracture, signs of basilar skull fracture, post-traumatic seizure, coagulopathy or anticoagulant therapy, vomiting, drug or alcohol intoxication, opium addiction, hypersensitivity to opiate analgesics, any concomitant injury, and refusal to participation in the study. The study was approved by the Medical Ethics Committee of the corresponding universities. Informed consent was obtained from all participants.

Patients were assessed by the attending physicians or supervised residents of emergency medicine. Headache was defined as any head pain, no matter diffuse or local. An initial dose of 0.05 mg/kg morphine sulfate was administered intravenously to all patients. After 15 minutes, the patients were assessed for presence or absence of headache (respectively equivalent to score ≥1 and 0 on 10-point visual analogue scale [VAS]). Had the headache persisted, another dose of intravenous morphine sulfate (0.05 mg/kg) was administered. Those patients still having headache 15 minutes after receiving the second dose of morphine were regarded as response-negative, and all others whose pain was relieved (score 0 on VAS) either by one or two dose(s) of morphine were considered response-positive. Since the evaluation process was completed before obtaining brain CT, the patients and the examiners were blind to the results of scanning.

Non-enhanced brain CT imaging was performed and the results were interpreted by staff radiologists blind to the results of clinical assessments. A brain CT scan was considered positive (abnormal) if any of the following lesions were present: Skull fracture, brain contusion, epidural hematoma (EDH), subdural hematoma (SDH), intra-cerebral hemorrhage (ICH),

Table 1. The frequency of pathologic findings in brain CT of patients in different age groups

Lesion	15-60 years	>60 years
Contusion	44	30
Epidural hematoma	39	16
Subdural hematoma	27	19
Skull fracture	19	12
Intra-cerebral hemorrhage	18	6
Subarachnoid hemorrhage	9	2
Intra-ventricular hemorrhage	1	2

Table 2. Primary and secondary outcomes according to the response of headache to IV morphine in patients aged 15-60 and >60 years

	15-60 (n=1667)			>60 (n=190)		
	Response +	Response –	Total	Response +	Response –	Total
CT +	0 (0*)	144 (4)	144 (4)	20 (2)	28 (5)	48 (7)
CT –	1363	160	1523	104	38	142
Total	1363	304	1667 (4)	124	66	190 (7)

*: Numbers in the parentheses indicate the number of patients requiring neurosurgical intervention.

subarachnoid hemorrhage (SAH), or intra-ventricular hemorrhage (IVH). Primary outcome was positive brain CT scan and secondary outcome was neurosurgical intervention.

Patients were divided into two age groups: 15-60 and >60 years. For each age group, outcomes were compared in response-positive and response-negative patients using cross-tabulation and Chi-square analysis. P-values ≤0.05 were considered statistically significant. Statistical analysis was performed using the SPSS software version 20 (SPSS, Inc., Chicago, IL).

RESULTS

A total of one thousand eight hundred and fifty-seven patients were included in the study. Three hundred and nighty-seven (21.4%) were female. Mean age of the participants was 35.5 years; 1667 (89.8%) aged 15-60 years and 190 (10.2%) were older than 60. The majority of patients (78.1%) had a GCS score of 15 (78.7% in the 15-60 and 73.2% in the over 60 years). Three hundred and twenty patients (17.2%) had a history of loss of consciousness or amnesia for the traumatic event (16.6% of 15-60 and 23.2% of >60). Of all patients, one hundred and ninety-two (10.3%; 8.64% of 15-60 and 25.3%of >60) had at least one lesion in CT. Brain contusion was the most prevalent pathologic finding in both age groups (Table 1). Eleven patients required neurosurgical intervention (0.6% overall; 0.240% of 15-60 and 3.68% of >60).

Table 3. CT findings of patients aged >60 years with a headache that was ameliorated by morphine

Pathology*	Frequency
Intra-cerebral hemorrhage	–
Contusion	9
Skull fracture	3
Subarachnoid hemorrhage	–
Subdural hematoma	8
Epidural hematoma	3
Intra-ventricular hemorrhage	–

*: Three patients had more than one lesion in the CT scan; one had skull fracture + epidural hematoma and two had skull fractures + brain contusions.

Of the one thousand six hundred sixty-seven patients aged between 15 and 60, the headache was relieved in 81.8% of the patients after administering intravenous morphine sulfate. Interestingly, none of these 1363 patients had any pathologic findings in the CT scan (Table 2). On the contrary, of the remaining three hundred and four patients in this age group whose headache was not responsive to morphine, 47.4% had abnormality in the CT scan and 4 required neurosurgical procedures. In >60 years age group, one hundred and twenty-four patients (65.3%) reported their headache to be ameliorated by morphine. However, twenty of them had pathologies in the CT scan (Table 3). Two patients in this category had subdural hematomas necessitating neurosurgical interventions.

Statistical analysis revealed a significant association between the response of headache to IV morphine and the results of brain CT in both age groups (Pearson Chi-Square=706.676 for 15-60 and 15.774 for >60; p-values <0.001). In other words, the rate of abnormal brain CT scan was significantly lower in patients whose headache was ameliorated by morphine. This protocol showed a sensitivity of 100%, specificity of 89.5% and accuracy of 90.4% for detecting abnormal CT scan in the age group of 15-60 years. In the age group of >60, though, sensitivity was 58.3% for the primary outcome and 71.4% for the secondary outcome.

DISCUSSION

The purpose of this study was to propose a new protocol in identification of cases that should undergo CT scanning in minor head injury of the adult population. Patients with minor head injuries, presenting with a GCS score of 14 or 15, and with a complaint of headache were assessed for the relief of the headache by morphine, and patients whose headache was relieved by morphine were compared to those who did not respond to morphine with respect to abnormal CT rate and rate of operative interventions. To the best of our knowledge, no previous study has assessed the association of pain relief by analgesics and pathologic findings in imaging studies. The results of this study put forward that in patients aged 15-60 years, the response of headache to morphine has a sensitivity of 100% for any abnormal findings in the brain CT scan. Therefore, we propose for this age group that a headache not relieved by morphine is an indicator for the need to

perform brain CT scan. This protocol can help physicians in rural areas with limited access to CT scan and neurosurgical services to decide on selecting patients to be transferred to an equipped center.

Morphine is one of the most widely used analgesics for trauma patients in the emergency departments.[31] However, patients with head trauma are less likely to receive opiate analgesics in the emergency departments due to the concern of masking the symptoms of traumatic brain injury and making the re-evaluation of patients difficult.[32] In addition, morphine has other unfavorable side effects such as respiratory depression, increase in intracranial pressure, hypotension,[33] and decrease in cerebral perfusion pressure.[34] Nevertheless, none of these effects were observed in our study. It seems that the concern is more prominent in critically ill and/or severely injured patients and in higher doses of morphine. Furthermore, effects of opiates can be reversed by administering opioid antagonists (e.g. naloxone). Thus, we feel that its benefit in pain management and presumed reduction of unnecessary referrals for CT scanning outweighs the risk.

Our suggested protocol has relatively low sensitivity for detecting abnormal CT scan (58.3%) and need for surgical intervention (71.4%) in patients over 60 years of age. There is evidence that due to age-related changes, threshold of injury is lower in elderly people and the guidelines used in the general population cannot be applied to this group.[18] As a result, brain CT scan is recommended for all elderly patients (>60[6] or >65[3] years of age) sustaining minor head injury.

Current study has some limitations. Most importantly, due to a deficit in the records of some patients, a multivariate analysis could not be performed. Therefore, the results cannot be attributed solely to the response of headache to morphine and the role of other variables such as history of amnesia or loss of consciousness and GCS score in predicting abnormal CT scan of the study population is unclear. Hence, the findings should be interpreted with caution. Another limitation is that although we had an optimal sensitivity of 100%, the protocol should be externally validated and tested on an extremely larger sample size before drawing this conclusion that those patients (under the age of 60) with a positive response of the headache to morphine can be safely excluded from referring for CT scanning if the clinical decision rules recommend otherwise. The idea opens a new horizon for future investigations.

Conclusion

This study suggests that the presence of a headache not relieved by morphine is a risk indicator which can be used as an adjunct to the existing criteria for selecting patients with minor head injury for the CT scanning. It can assist in making the decision of transferring patient in centers where CT scan is not accessible. This factor should be validated in future studies with larger sample sizes.

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Conflict of interest: None declared.

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KLİNİK ÇALIŞMA - *ÖZET*

Minör baş travmasında beyin BT taraması çekmeden önce baş ağrısı tedavisinin rolü: İntravenöz morfin sülfat kafa içi travmasını öngörebilir mi?

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AMAÇ: Bu çalışmanın amacı, beyin BT taramasında minör kafa travması (MHI) bulguları olan hastalarda baş ağrısının morfine yanıtını incelemek ve BT taraması gereken hastaları tanımlamak için yeni bir risk göstergesini önermektir.
GEREÇ VE YÖNTEM: Baş ağrısı ve GCS skoru 14 veya 15 ile gelen 15 yaş ve üstü toplam 1857 MHI hastası çalışmaya alındı. İntravenöz morfin sülfat yapıldı ve hastalar daha sonra baş ağrısının geçmesi veya süregelmesine göre değerlendirildi. Daha sonra tüm hastaların beyin BT taraması çekildi.
BULGULAR: Hastalar 15-60 ve 60 yaş üstü olmak üzere iki yaş grubuna ayrıldı. Her iki grupta BT sonucu ile morfine yanıt arasında önemli bir ilişki mevcuttu ($p<0.001$). On beş ile 60 yaş arasında, baş ağrısı morfine yanıt vermiş olanların hiçbirinin BT taramasında herhangi bir anormal bulgu görülmedi (duyarlılık= %100). Altmış yaş üstü grupta anormal BT bulgusu ve nöroşirürji girişim endikasyonu açısından morfine yanıtın duyarlılık dereceleri sırasıyla %58.3 ve %71.4 idi.
TARTIŞMA: Bu çalışma morfinle geçmeyen baş ağrısının kafa içi travması için bir risk göstergesi olduğunu düşündürmektedir. BT'ye erişimin sınırlı olduğu kırsal alanlarda, BT taraması endike MHI hastalarının seçimine ilişkin mevcut kriterlere ek olarak bu protokol kullanılabilir.

Anahtar sözcükler: Ağrı yönetimi; baş ağrısı; beyin yaralanmaları; bilgisayarlı tomografi; kraniyoserebral travma; morfin.

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CASE SERIES

Treatment and results in pediatric traumatic hip dislocation: Case series and review of the literature

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ABSTRACT

BACKGROUND: Six acute traumatic hip dislocations in pediatric patients were retrospectively analyzed. Types of dislocations, associated lesions, treatment methods, complications, and clinical and radiological outcomes were reviewed.

METHODS: Six child patients treated due to traumatic hip dislocation between 2007 and 2011 in our clinic were included in the study. While five of the patients were male, one was female; the average age was 8 years and 8 months. The mean follow-up was 25.2±10 months. There were posterior dislocations in five cases and transepiphyseal fractured dislocation in one case. Four cases were treated by closed reduction while two cases were treated with open reduction method.

RESULTS: In the last control of the patients, asymmetric widening in the hip joint was found due to osteochondral fracture in one patient and coxa magna occurred in one patient. Avascular necrosis developed in one case with transepiphyseal fractured dislocation. Harris hip score evaluation was found excellent in five cases and bad in the case with fractured dislocation.

CONCLUSION: Traumatic hip dislocation is a rare condition. It should be treated with preferably closed method as soon as possible. Repetitive reduction trials should be avoided. Open reduction should be performed to recognize accompanying lesions after advanced radiologic examinations such as computerized tomography and magnetic resonance imaging.

Key words: Child; hip dislocation; trauma; treatment.

INTRODUCTION

Traumatic hip dislocation (THD) is rarely encountered in childhood. Therefore, a lot of series consist small number of patients in the literature.[1-5] Traumatic hip dislocation usually develops as a result of minor trauma. Owing to the elasticity of the periarticular structures in children with THD, associated acetabulum or femoral head fracture is rarer in comparison to adults.[6] Transepiphyseal fractured dislocation is also very rare in children.[7,8]

In patients with THD, bad functional and radiologic results may occur due to complications such as femoral head avascular necrosis (AVN) and posttraumatic arthritis. AVN is usually associated with delay in reduction time.[9] Early diagnosis and concentric closed reduction are critical issues in the treatment of THD. If closed reduction cannot be achieved or concentric reduction cannot be obtained, these patients should be treated by open reduction. In addition, open reduction is also the first choice in patients with fracture-dislocation.

Six acute traumatic hip dislocations in pediatric patients were retrospectively analyzed in this study. Types of dislocations, associated lesions, treatment methods, complications, and clinical and radiological outcomes were also reviewed.

MATERIALS AND METHODS

Six pediatric patients with THD treated in our clinic between 2007 and 2011 were evaluated retrospectively. The collected data included age and sex, type of injury, type of dislocation, associated lesions, the interval between injury and reduction of the dislocation, method of treatment, and complications. The data was collected by computer data and medical charts. Characteristic features of the patients were given in Table I.

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Table 1. Characteristic features of the patients

Patient No.	Age (year, month)	Gender	Trauma mechanism	Type of dislocation	Time to areatment	Associated lesions	Type of treatment	Complications (month)	Follow-up (HHS)	End result
1	6y, 9m	Female	Another child falls on her leg	Posterior	2 hours		Closed reduction and skin traction		40	Excellent
2	5y, 9m	Male	Fall at play	Posterior	2 hours 30 minutes		Closed reduction and skin traction		28	Excellent
3	8y, 2m	Male	Fall from wall	Posterior	4 hours		Closed reduction and skin traction		30	Excellent
4	10y, 9m	Male	Fall at playing football and then while sleeping	Posterior	8 hours	Fracture of acetabular roof epiphysis and little bone fragment with posterior capsuloligamentous separation	Open reduction and spica cast	Coxa magna	25	Excellent
5	9y, 11m	Male	Another child falls on his leg	Posterior	3 hours 15 minutes	Osteochondral fracture of the posterior acetabular wall	Closed reduction and skin traction	3 mm joint space asymmetry	16	Excellent
6	10y, 11m	Male	Hit by car	Superior-posterior	16 hours 30 minutes	Transepiphyseal fracture-dislocation	Open reduction and hip abduction device	AVN / Posttraumatic arthritis	12	Poor

Out of the six patients, five were male and one was female. The mean age at diagnosis was 8 years and 8 months (range, 5 years and 9 months-10 years and 11 months). The mean follow-up was 25.2±10 months (range, 12-40 months). Four cases were applied closed reduction under sedation and analgesia in the emergency room within an average of 2 hours and 57 minutes following dislocation (range, 2-4 hours). THD occurred as a result of low-energy trauma in four patients and high-energy trauma in two.

In five patients, hip dislocations were towards the posterior. Moreover, in a patient with transepiphyseal fractured dislocation, it was superior-posterior. Four patients were treated with closed reduction and two were treated with open reduction. The patients treated with closed reduction were applied bed rest and skin traction after the reduction. In one of the two patients treated with open reduction, spica cast was used and in the other patient, hip abduction device was used. The patients treated with closed reduction were permitted to full weight bearing at the sixth week.

All cases were evaluated clinically and radiologically at the third, sixth, twelfth months, and last follow-up. Harris hip score was used for functional evaluation. Joint space widening of 2 mm or more was defined as asymmetric enlargement of the hip joint. In comparison to unaffected side, the diameter of the femoral head difference more than 2 mm was defined as coxa magna.

RESULTS

Five of the six patients treated with closed reduction had

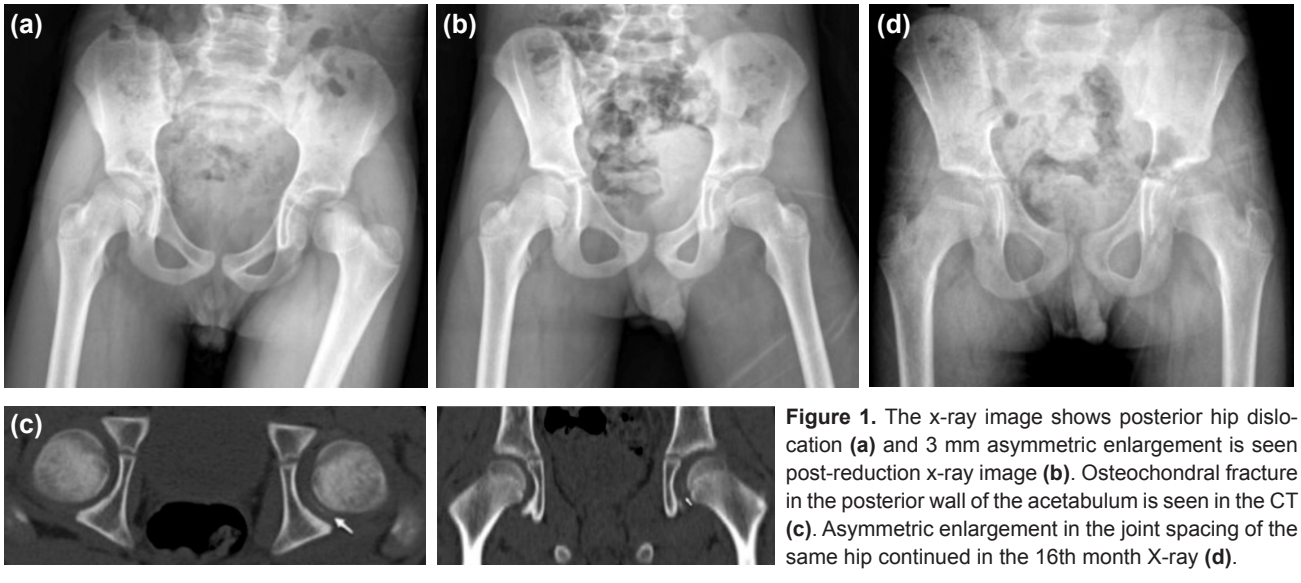

Figure 1. The x-ray image shows posterior hip dislocation **(a)** and 3 mm asymmetric enlargement is seen post-reduction x-ray image **(b)**. Osteochondral fracture in the posterior wall of the acetabulum is seen in the CT **(c)**. Asymmetric enlargement in the joint spacing of the same hip continued in the 16th month X-ray **(d)**.

painless, full range joint movements and no limping in their last follow-up. They received 100 points from Harris hip score evaluation. None of these cases had sciatic nerve injury or recurrent dislocation.

In the last controls, there were no radiological or clinical leg length discrepancy, heterotrophic ossification, early epiphysis closure, posttraumatic arthritis, and avascular necrosis in five patients. In one patient, there were leg length discrepancy, AVN, and posttraumatic arthritis.

Illustrative Cases

Case no. 1 (Patient no. 5)

A 10-year-old male patient in whom posterior hip dislocation occurred as a result of another child falling down on his affected leg while playing games (Figure 1a). After closed reduction, 3 mm asymmetric widening in the hip joint was found compared to the normal side (Figure 1b). The hip was stable during physical examination. Osteochondral fracture in the posterior wall of the acetabulum was seen in post-reduction CT imaging (Figure 1c). The patient was treated with skin traction and bed rest for a month. At the sixteenth month follow-up control, although 3 mm asymmetric enlargement continued, his hip had full range of motion and was completely painless (Figure 1d).

Case no. 2 (Patient no. 4)

An 11-year-old male patient in whose left hip a posterior dislocation developed while sleeping after sports injury (Fig. 2a). Closed reduction was tried under sedation and analgesia in the emergency room at the fourth hour after dislocation, closed reduction was achieved but re-dislocation developed secondary to instability during physical examination. In magnetic resonance (MR) and computerize tomography (CT), torn of capsulolabral complex was seen with apophyseal avulsion fractures from the acetabular edge. By injuring surrounding soft tissues, dislocated femoral head changed the location of superior-posterior (Figure 2b-d). There was abundant hematoma inside the joint and anterior labrum moved into the joint (Figure 2e). Osteochondral fracture was not determined. The patient was treated by open reduction with posterior approach at the eighth hour. Capsulolabral complex was repaired with absorbable sutures. Pelvipedal plaster cast was applied. Range of motion exercise was started and the patient was allowed to lower extremity partial weight bearing after the plaster was removed at the sixth week. At the twenty-sixth month x-ray control of the patient, 6 mm coxa magna was seen in the dislocated hip (Figure 2f).

Case no. 3 (Patient no. 6)

A 10-year and 11 month-old male patient in whose left hip a transepiphyseal fractured dislocation developed as a result of a traffic accident. It was seen that the fractured femoral head epiphysis moved to superior-posterior in the X-ray and CT image (Figure 3a, b). Open reduction was made by anterior approach at the twelfth hour without attempting closed

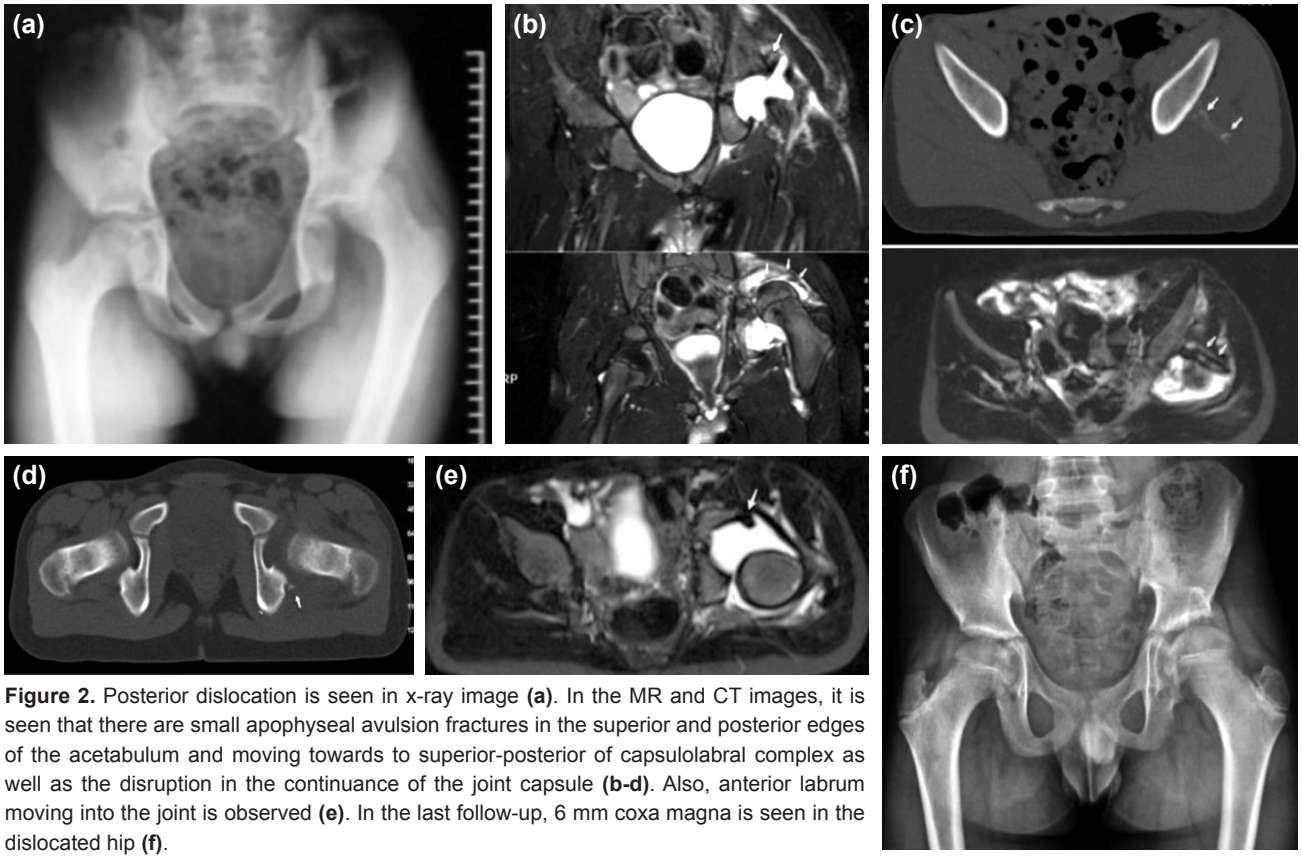

Figure 2. Posterior dislocation is seen in x-ray image **(a)**. In the MR and CT images, it is seen that there are small apophyseal avulsion fractures in the superior and posterior edges of the acetabulum and moving towards to superior-posterior of capsulolabral complex as well as the disruption in the continuance of the joint capsule **(b-d)**. Also, anterior labrum moving into the joint is observed **(e)**. In the last follow-up, 6 mm coxa magna is seen in the dislocated hip **(f)**.

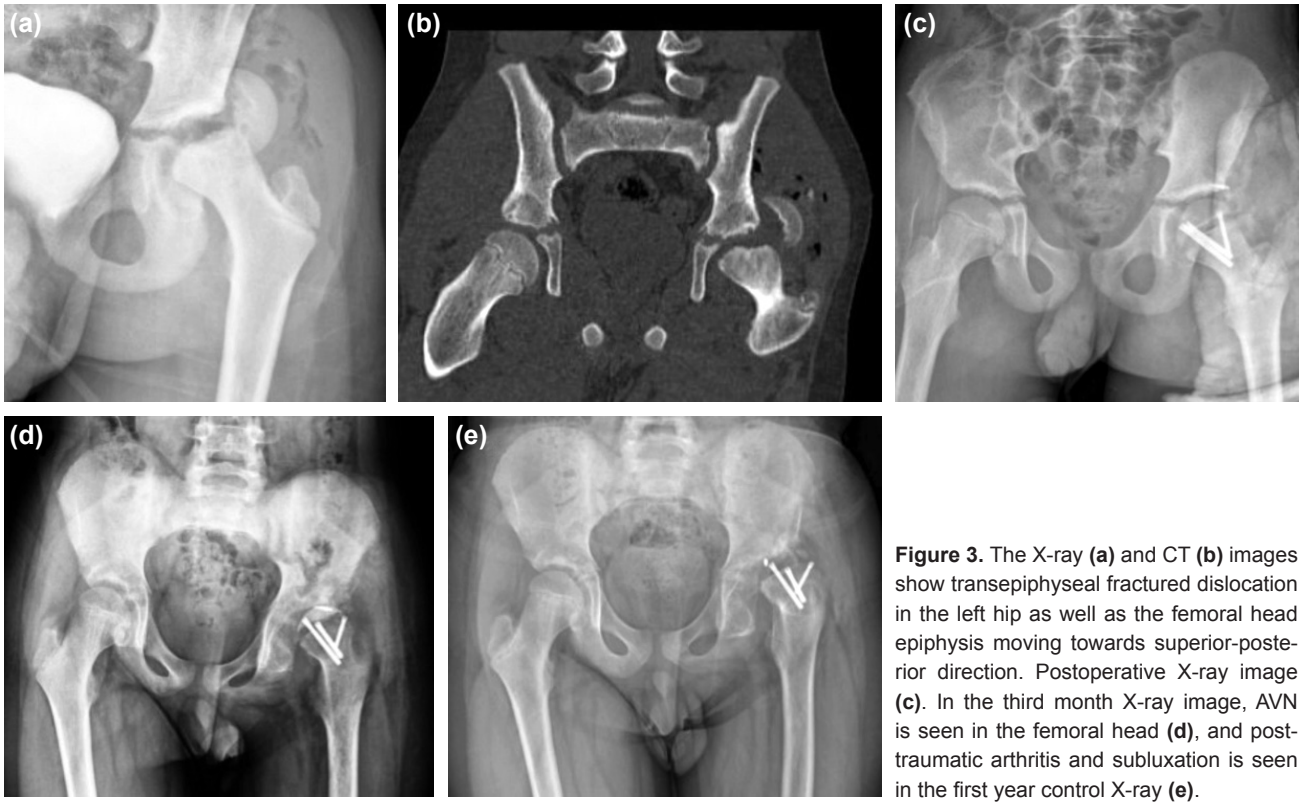

Figure 3. The X-ray **(a)** and CT **(b)** images show transepiphyseal fractured dislocation in the left hip as well as the femoral head epiphysis moving towards superior-posterior direction. Postoperative X-ray image **(c)**. In the third month X-ray image, AVN is seen in the femoral head **(d)**, and posttraumatic arthritis and subluxation is seen in the first year control X-ray **(e)**.

reduction. After the transepiphyseal fracture had been fixed by three retrograde Herbert screws, the hip was reduced. Injured capsulolabral complex was repaired with anchor suture (Figure 3c). Patient's hip was stabilized with hip abduction device for two months. He was permitted to walk with partial weight bearing at the eighth week and full weight bearing in the tenth. At the third month follow-up, AVN occurred in the femoral head (Figure 3d). Posttraumatic arthritis and subluxation were determined at the first year follow-up (Figure 3e). Furthermore, there were 1.5 cm leg length discrepancy and restriction and pain in his hip movements. Harris hip score of this case was 61.

DISCUSSION

Traumatic hip dislocation is a rare condition with a bad prognosis due to potential complications in children. THD usually occurs as a result of low energy traumas such as simple falls and sport injuries in children under the age of ten.[1,10-13] Higher energy traumas such as falls from height and traffic accidents are prominent in children over the age of ten.[14,15] THD is classified as anterior, posterior, central and inferior. It is three to four times more frequently encountered in boys than girls.[5,16-18] Posterior dislocations are much more frequent than anterior dislocations similar to the adult age group.[5,6,14,19] Our findings were consistent with the literature.

The main treatment modality is closed reduction of the THD under sedation or general anesthesia as soon as possible, preferably within the first six hours.[9,16,19-21] If THD cannot be reduced by closed method, open reduction should be performed. However, open reduction may cause additional vascular injury leading to AVN and posttraumatic arthritis[16]. After closed reduction, the hip should be evaluated for its stability by physical examination and concentric reduction should be confirmed by X-ray imaging.

Concentric reduction may not be obtained due to intraarticular osteochondral lesion and massive hematoma, as well as incarceration of the muscles, tendons, torn capsulolabral complex, and ligamentum teres.[18,22,23] Although bone and osteochondral lesions are better evaluated with CT, MRI is more superior for evaluating trapped soft tissues in the joint, as well as capsular lesions and surrounding muscle and tendinous structures. Especially, if concentric reduction cannot be provided in older children, osteochondral fracture should be kept in mind.[17,18] In their study, Mehlman et al.[16] had not encountered any radiological or functional sequel in four patients with up to 6 mm asymmetric joint enlargements after closed reduction. Vialle et al.[17] had not determined any correlations between the severity of trauma and soft tissue entrapment or osteochondral fracture in their study. In our study, osteochondral fracture was encountered in only one patient as a result of low energy trauma.

THD complications are much rarely encountered in children than adults except for recurrent dislocation.[6,20,24,25] Recurrent dislocation usually develops based on a defect or joint capsule laxity. In the literature, recurrent dislocations are more com-

monly seen especially in children with two weeks or and less immobilization or allowed early ambulation.[20,25] None of our cases developed recurrent dislocation. Thus, it is our belief that in children under the age of ten, immobilization for four weeks along with suitable rehabilitation is particularly important for the healing of surrounding soft tissues to make the joint become stable.

In children, THD may also lead to complications such as femoral head avascular necrosis, sciatic nerve palsy, posttraumatic degenerative arthritis, and coxa magna. Recent studies have reported that the sciatic nerve palsy is the most common complication. In the literature, sciatic nerve palsy has been found between 5% and 20%.[14,19] However, among all complications, AVN has the worst prognosis.[12,14,19]

The velocity of trauma, age at the time of injury, the interval between initial trauma and reduction, and fractured dislocation have been emphasized as predisposing factors in the development of AVN.[9,13,21,26] The possibility of AVN increases in older children.[1,6,12] High energy trauma also increases the risk of AVN development.[3,9] AVN usually develops in the first three years.[14,19] In the literature, AVN rate has been reported 3-15% in patients whose reduction has been performed in six hours. AVN rate reaches up to 100% in neglected THD patients[9,13,15-17,19,27] However, recent studies have found that AVN rate is less than 5%.[12,17] Additionally, AVN rate has been reported 80-100% in children with fractured dislocation.[9,28-30] AVN developed in none of the patients with isolated hip dislocation in this study.

Growth disturbance develops due to proximal femoral physis damage and affects especially children under the age of 12 and it may lead to leg length discrepancy and angular deformities in the femoral neck.[9] Growth disturbance usually emerges as coxa magna in children older than 12 years. Physeal damage can be directly related to trauma and it may also occur due to fracture, AVN, synovitis, and reactive hyperemia.[13,15] Coxa magna was encountered in only one patient in the present study.

Posttraumatic arthritis usually develops nearly four years after the trauma and is usually associated with avascular changes and intraarticular fractures.[6,14,24] Radiological changes in these patients emerge much later. Radiologic arthritic findings appeared in a patient in this study in the first year due to intraarticular penetration of the fixation materials and development of AVN. Retrograde fixation is not recommended because of its difficult removal and risk of joint penetration. It is our opinion that anchor suture in the acetabular edge does not provide sufficiently stabile fixation in pediatric cases, and therefore, it should not be used close to the joint.

General opinion is to allow partial weight bearing of patients at the fourth or sixth weeks and then pass onto full load.[1,2,6,16,20] Prolonged immobilization and no weight bearing of the affected leg do not decrease AVN incidence and severity.[9,21] A similar treatment protocol was applied in our cases. Functional results of the patients with THD are usually very good.[2,3,16-18] In contrast, poor results are often related to accompanying injuries and AVN. However, functional results have been found good in the majority of the patients with AVN.[17,18,25] The limitations of the present study were small number of patients and short follow-up period.

Especially in children, THD should be diagnosed rapidly and must be treated urgently. Repetitive closed reduction trials should be avoided. If it is not possible to obtain a stable closed reduction, advanced imaging techniques such as CT and MRI should be carried out for investigating prohibitive causes. If closed reduction is not successful, open reduction should be considered. It should be kept in mind that the rate of avascular necrosis may reach up to 100% in cases with transepiphyseal fracture accompanied by dislocation.

Conflict of interest: None declared.

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OLGU SERİSİ - *ÖZET*

Pediatrik travmatik kalça çıkığı tedavi ve sonuçları: Olgu çalışması ve literatürün gözden geçirilmesi

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AMAÇ: Akut travmatik kalça çıkığı olan altı çocuk hasta geriye dönük olarak incelendi. Bu hastalarda çıkığın tipi, ilişkili lezyonlar, tedavi yöntemleri, komplikasyonlar, klinik ve radyolojik sonuçlar değerlendirildi.

GEREÇ VE YÖNTEM: Kliniğimizde 2007 ile 2011 tarihleri arasında travmatik kalça çıkığı nedeniyle tedavi edilmiş olan altı çocuk hasta çalışmaya alındı. Hastaların beşi erkek, biri kız, ortalama yaş 8 yıl 8 ay (dağılım; 5 yıl 9 ay-10 yıl 11 ay). Olguların ortalama takip süreleri 25.2±10 aydı. (dağılım 12-40 ay). Beş olguda posterior çıkık, bir olguda ise transepifizyal kırıklı çıkık mevcuttu. Dört olgu kapalı, iki olgu ise açık redüksiyon yöntemiyle tedavi edildi.

BULGULAR: Hastaların son takibinde, bir hastada osteokondral kırığa bağlı eklem mesafesinde asimetrik genişleme saptandı, diğer bir hastada koksa magna gelişti. Transepifizyal kırıklı çıkığı olan bir olguda avasküler nekroz gelişti. Beş olguda Harris hip skoru değerlendirmesi mükemmel, kırıklı çıkık olgusunda ise kötü olarak bulundu.

TARTIŞMA: Bu oldukça nadir karşılaşılan olgular mümkün olan en kısa sürede öncelikle kapalı yöntemle tedavi edilmelidir. Tekrarlayan kapalı redüksiyon denemelerinden kaçınılmalı, redükte olmayan olgularda eşlik eden lezyonların önceden tanınması için mümkünse BT ve MR görüntüleme gibi ileri incelemeler yapıldıktan sonra açık redüksiyona geçilmelidir.

Anahtar sözcükler: Çocuk; kalça çıkığı; tedavi; travma.

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KLİNİK ÇALIŞMA

Pediküllü rektus abdominis kas deri flebinin uyluk ve sırt defektlerinde kullanımı

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ÖZET

AMAÇ: Daha önce tanımlanmış, fakat az kullanılan "ekstended" veya vertical rektus abdominis muskulokutan ("Ekstended" RAM, VRAM) fleplerinin çok nadir endikasyonlardaki kullanımları incelendi.

GEREÇ VE YÖNTEM: Beş hastada, 28x8 ile 35x10 cm ebatlarında cilt adası içeren flepler kullanıldı. Dört flep uyluk ve diz proksimal bölgedeki defekt onarımları için inguinal ligamentin altından, bir flep lomber gölgedeki defekt onarımı için transabdominal olarak defekt alanlara taşındı.

BULGULAR: Hiçbir olguda flep kaybı görülmedi. Bir olguda yara yeri enfeksiyonu gelişti ve cerrahi ile tedavi edildi. Uyluk ve lomber bölge defektleri onarımlarında düşük komplikasyon oranlarıyla "ekstended" RAM ve VRAM fleple başarılı transfer gerçekleştirildi ve çok güvenli ve uygun bir seçenek olduğu sunuldu.

SONUÇ: Avantajları bol miktarda ve iyi kanlanan doku taşımasını sağlar, flep kolay ve hızlı hazırlanır ve mikrocerrahi deneyimi gerektirmez.

Anahtar sözcükler: Pediküllü rektus abdominis kas deri flebi; uyluk ve sırt defektleri.

GİRİŞ

Rektus abdominis muskulokutan (RAM) flep Mathes-Nahai sınıflamasına göre tip 2 fleptir. Vasküler yapısının güvenli olması, büyük hacimde ve ebatlarda kaldırılabilmesi, pedikülün uzun olmasından dolayı gerek serbest flep olarak gerekse inferior ve superior pediküllü olarak sternal, kasık, perine, pelvik ve vaginal defektlerin onarımlarında kullanılmıştır.[1,2] Ancak uyluk bölgesindeki defekt onarımlarında kullanımı daha az yaygın olup[3-9] sırt bölgesinde kullanımı oldukça nadirdir.[10-14]

Çalışmamızın amacı; uyluk ve sırt bölgesinde doku defektleri olan veya femur orta seviyesinde amputasyon sonrası yeterli yumuşak doku desteği olmayan olgularda RAM flebiyle onarımları sunmak, flep hazırlanışındaki teknik detayları ve flebin avantajlarını literatür eşliğinde tartışmaktır.

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GEREÇ VE YÖNTEM

Çalışmaya Kasım 2012 ve Haziran 2013 yılları arasında inferiyor tabanlı RAM flebi ile onarılan uyluk, sırt bölgesi defektleri ile femur orta seviyesinden amputasyon güdüklerinde yumuşak doku yetersizliği olan hastalar alındı. Flep boyutları, hasta demografileri, hastanede kalış süreleri ve ameliyat sonrası komplikasyonlar incelendi.

Cerrahi Teknik

Tüm hastalara genel anestezi altında ve sırtüstü yatar pozisyondaiken ameliyata başlandı. Flep uyluk bölgesi onarımı için kullanılacak olgularda ipsilateral, sırt defekti olan olgu için ise sağ taraftan planlandı. Defektin ve doku gereksinimine göre VRAM veya "ekstended" RAM şeklinde ve donör alan primer olarak kapatılabilecek şekilde tasarlandı. Cilt ve ciltaltı dokular geçildikten sonra lateralde eksternal oblik fasya üzerinden disseke edildi. Flep tranferi sonrası abdominal bölgedeki fıtıklaşmayı minimize etmek için anterior rektus fasyasına ulaşıl-

dığında cilt adasına giden perforatörler iskeletize edilmeden mümkün olduğu kadar fasyayı flebe dahil etmeden diseksiyona devam edildi. Rektus kası görüldükten sonra posteriyor fasyasından, süperiyor kostal ve sternal bağlantılarından ayrıldı. Flep inferiyor pedikül üzerinden ada şeklinde tamamen kaldırıldı. Daha sonra olgu 1 hariç tüm olgularda rektus kasının pubik kemik ve simpisis pubis ile bağlantıları tamamen ayrıldı. Olgu 1 hariç, flepler defekt alana inguinal ligementin altından oluşturulan tünel ile transfer edildi. Olgu 1'de flep inferiyor pedikül üzerinden kaldırıldıktan sonra steril örtüler ile sarıldı. Flep ekstraperitonel-abdominal kasların altındaki plandan ve lomber bölgedeki Petit fizyolojik üçgeni içerisinden oluşturulan bir tünel yardımı ile lomber bölgedeki defekte transfer edildi. Anteriyor rektus fasyası tüm olgularda kalıcı sütürler ile tek tek primer olarak kapatıldı. Üzerine prolen mesh örtü konularak güçlendirildi. Donör alana iki adet ve flep altına bir adet hemovak dren yerleştirildi. Olgu 4 ve 5'te ise flep laterallerindeki yüzeyel doku defektleri diğer uyluk ön yüzünden hazırlanan kısmi kalınlıkta cilt greftler ile onarıldı.

Ameliyat Sonrası Bakım

Olgu 1 hariç hasta yatağına alındıktan sonra kalça eklemine 30 derece fleksiyonda olacak şekilde pozisyon verildi. Üçer gün ara ile kalça fleksiyonu 15 derece ve tam ekstansiyonlara getirilerek takip edildi. Olgu 1, iki hafta boyunca sırtüstü pozisyon dışında pozisyonlar verilerek takip edildi. Daha sonra sırtüstü yatma programlarına başlandı. Tüm olgularda drenler operasyondan sonra üç ile altıncı günler arasında çekildi. Tüm hastalara antibiyotik olarak birinci kuşak sefalosporin (14 gün), analjezik olarak nonsteroid antienflamatuvar tedavileri uygulandı ve gerektiğinde Tramadol Hcl amp (1 mg/kg dozunda, kas içine enjeksiyonla) ile ilave analjezi destekleri de sağlandı. İki olguda enfeksiyon gelişmesi üzerine enfeksiyon hastalıkları tarafından konsülte edilerek medikal tedavilerine imipenem ve vankomisin antibiyoterapileri ilave edildi. Tüm hastalar yattığı süre boyunca tromboemboli profilaksisi için enoksaparin sodyum (subkütan enjeksiyon yoluyla günde bir kez 2000 anti-Xa) verildi.

BULGULAR

Çalışmaya toplam bir kadın dört erkek hasta olmak üzere beş hasta alındı. Hastaların yaşları ortalaması 30.6 (11-77 yaş). Hastanede kalış süreleri 17.8 gün (13-26 gün) ve ortalama takip süreleri 109.6 gün (40-186 gün) idi. Tüm hastalarda etiyoloji travma (ateşli silah yaralanması ve mayın patlaması) idi.

Defekt lokalizasyonları;

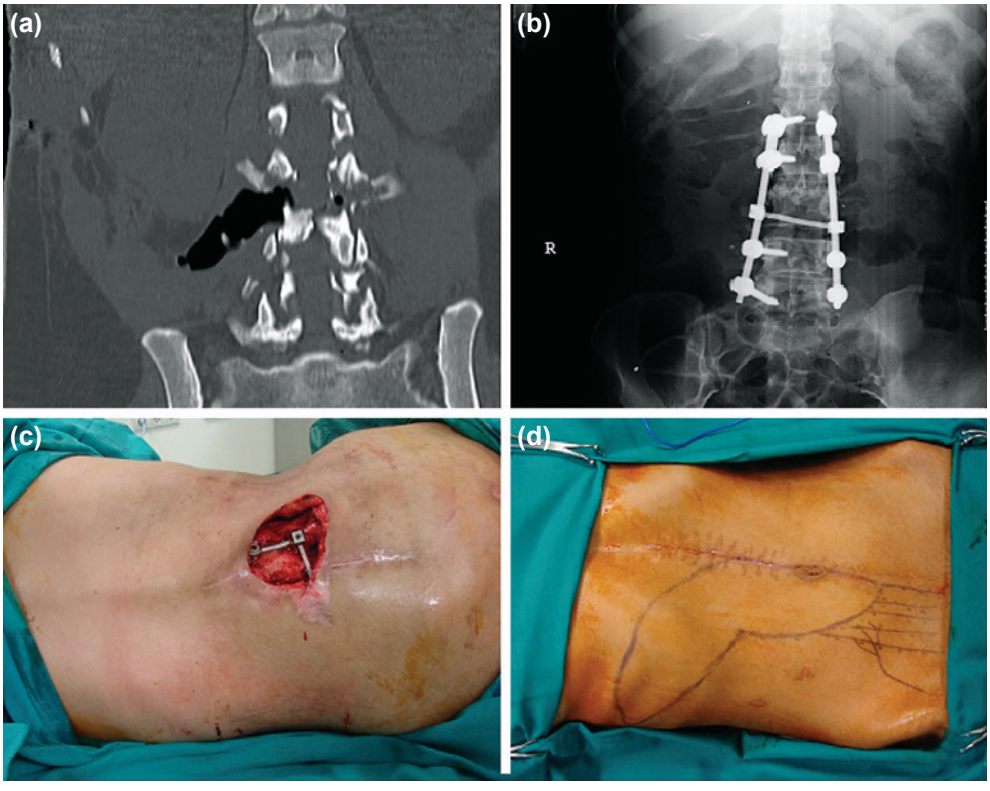
- Üç hasta femur orta 1/3'ü (Olgu 2 ve Olgu 3: sırasıyla yedi ve dört ay önce sağ femur orta seviyesinden ampute, bacak protez kullanımına engel olacak derecede distal kemik üzerindeki yumuşak doku örtüsü yetersiz; Olgu 5: parçalı mid-femoral-parçalı-cisim kırığı, nonünion, ostemyelit ve kemik ekspoze, 20x13 cm'lik yumuşak doku defekti mevcut.)
- Bir hasta femurun distal 1/3'ü (Olgu 4: kuadriseps femoris kas-tendinoz bileşkesinde kas kaybı, femur parçalı defektif kırığı, nonunion, kemik ekspoze, 25x20 cm'lik yumuşak doku defekti mevcut.)
- Bir hasta ise sırt bölgesi (Olgu 1: L2-L5 omurga arasında lomber stabilizasyon enstrümanını ve omurga kemiklerini açığa çıkaran yaklaşık 16x12x7 cm ebadında doku defekti mevcut).

Hastalardan Olgu 2, 3, 4, 5 takipleri taburcu sonrası telefon ile yapıldı. Hastalardan olgu 2 ve olgu 3 operasyon sonrası 28 ve 33. günlerde protez bacak takılarak mobilize edildiği öğrenildi. Olgu 4 defektif uyluk bölgesindeki yaraların tamamen iyileştiği ve başka merkezde defektif femur kırığı nedeniyle intramedüller çivileme ile kırık fiksasyonunun sağlandığı öğrenildi. Olgu 5 ise operasyon sonrasında eksternal fiksatör ile femurun tekrar redükte edildiği ve VRAM flep ile onarımından 34 gün sonra yürütücü desteği (walker) ile mobilize edildiği öğrenildi.

Olgu 1 hariç tüm olgularda operasyon sonrası geçici venöz yetmezlik tespit edildi. Ameliyat sonrası bakımda anlatıldığı gibi hastaya pozisyon verilmesiyle (kalça fleksiyonu) yetersizlik bulguları kayboldu. Hiçbir olguda kısmi veya total flep kaybı gözlenmedi. Olgu 4'te operasyon sonrası flep altında pürülan drenaj şeklinde yara yeri enfeksiyonu gelişti. Yedi gün açık yara bakımı, ilave medikal tedavi (vankomisin, imipenem) ve flep yaklaşık distal 7 cm'lik kısmının de-epiteliz edilerek femur defektif kırık alanına gömülmesi şeklinde ikincil bir operasyonla tedavi edildi. Aynı olguda flep lateral alanlarında kısmi cilt greft kayıpları tespit edildi. Hiçbir olguda abdominal fıtık veya karın içi bir patoloji tespit edilmedi.

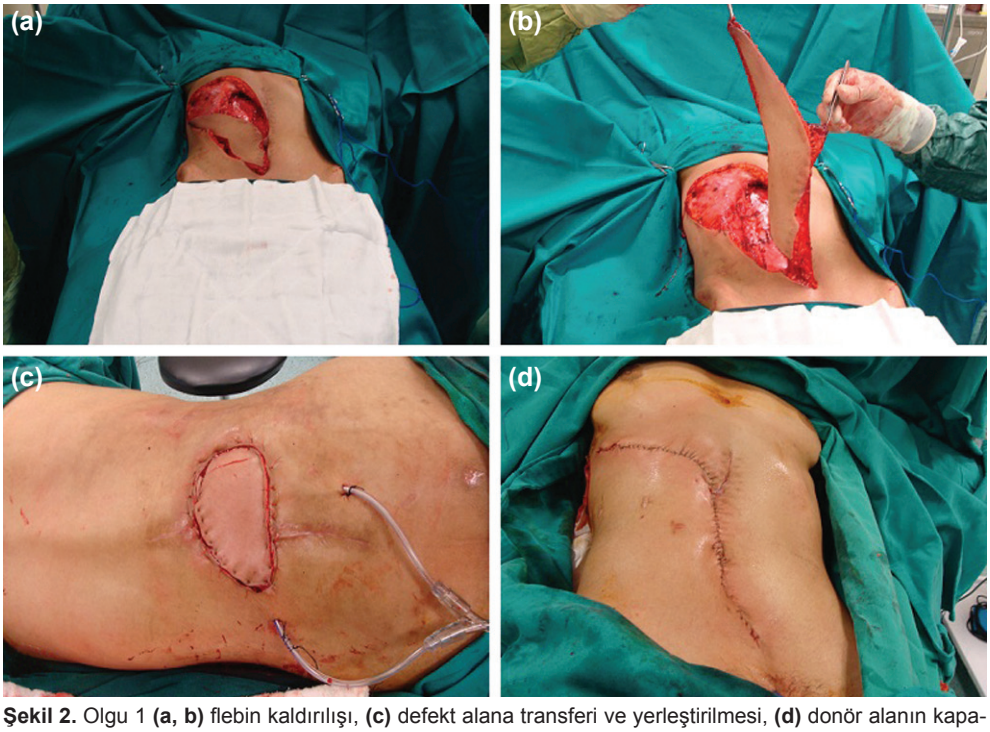
Olgular

Olgu 1 – On dokuz yaşında kadın hasta Suriye'de iç savaş sırasında ateşli silah yaralanması neden olduğu lomber omurgalarda parçalı kırık (Şekil 1a) ve karın içi organ yaralanmaları nedenleriyle beyin cerrahi ve genel cerrahi kliniklerince ameliyat edilmiş. Takiben sırt bölgesinde doku defekti gelişmesi üzerine kliniğimize sevk edilmiştir. Fiziksel incelemesinde hastanın paraplejik olduğu, lomber bölgede L2-L5 arasında lomber stabilizasyon enstrümanını (Şekil 1b) ve omurga kemiklerini açığa çıkaran yaklaşık 16x12x7 cm ebadında doku defekti (Şekil 1c), defektin sağ lateralinde yaralanma sırasında oluşmuş yaklaşık 10 cm'lik kesi skarı, geçirilmiş abdominal cerrahiye bağlı göbek üstü ve altı median kesi skarı mevcut (Şekil 1d) olduğu kaydedildi. Hastanın beyin cerrahi tarafından operasyonu sırasında latissimus dorsi kasının omurgaya yakın minör dallarının hasarlaşmış olabileceği düşüncesiyle reverse latissimus dorsi kas transferinin uygun olmayacağı, defektin etrafından random çevrilecek fasyokutan flebin ölü boşluğu doldurmaları açısından yetersiz kalabileceği ve defekt etrafında kesi skarları olduğundan uygun olmayacağı gerekçeleriyle transabdominal RAM transferi düşünüldü. Defektin sakrumun daha süperiyor bölgesinde yerleşim göstermesi üzerine 35x10



Şekil 1. Olgu 1 **(a)** lomber omurgada parçalı kırık (BT), **(b)** stabilisasyon entsturmanı yerleşimi (ön-arka görünüm), **(c)** sırtta omurga kemiklerini açığa çıkaran doku defekti, **(d)** "ekstended" RAM flebin planlanması ve geçirilmiş abdominal cerrahi skarı.

cm ebadında "ekstended" RAM flebi planlandı (Şekil 1d). Flep "ekstended" kısmı subfasiyal planda ve diğer kısmı ise cerrahi teknik kısmında anlatıldığı gibi hazırlandı. Sağ derin inferior epigastrik arter ve ven eksternal iliak damarlardan dallandığı yere kadar disseke edildi. Diğer olgulardan farklı olarak rektus kasının pubik kemik ile olan bağlantıları serbestlenmedi (Şekil

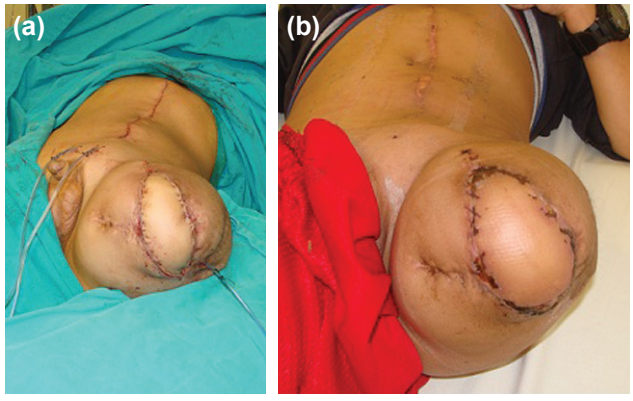


Şekil 2. Olgu 1 **(a, b)** flebin kaldırılışı, **(c)** defekt alana transferi ve yerleştirilmesi, **(d)** donör alanın kapatılması.

Şekil 3. Olgu 1, flebin ameliyat sonrası yedinci gün görünümü.

2a, b). Bundan sonra hasta sol lateral dekübit pozisyonuna alındı. Flep steril örtüler ile sarıldıktan sonra pedikül torsiyonu olmayacak şekilde ekstra-peritoneal fakat submusküler yol ile lomber bölgenin en zayıf yerlerinden olan petit üçgeninden oluşturulan tünel yardımıyla tranfer edildi (Şekil 2c). Flebin karın içinde kalan kısmı işaretlendi ve de-epitelize edildi. Donör alan diğer olgulardaki gibi kapatıldı (Şekil 2d). Ameliyat sonrası takip edilen süre içerisinde donör alanda veya onarım bölgesinde herhangi bir komplikasyon yaşanmadı (Şekil 3).

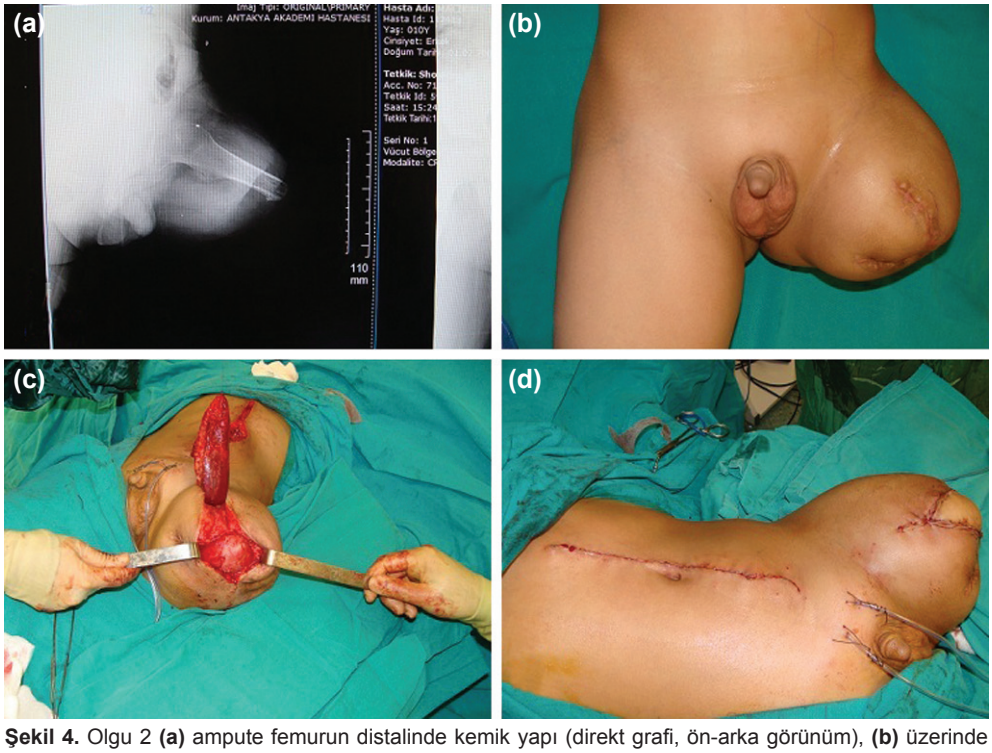
Olgu 2– On bir yaşında erkek hasta yedi ay önce Suriye'de iç savaşta mayın patlamasına bağlı sol femur orta seviyesinden ampute olmuş ve primer olarak güdük onarımı yapılmış.



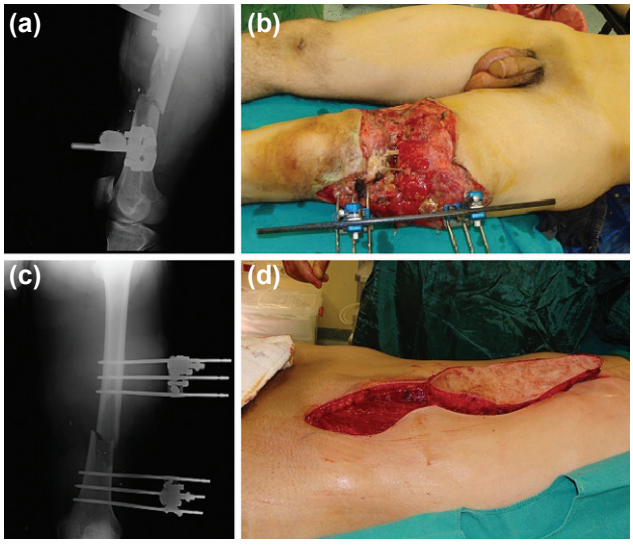
Şekil 5. Olgu 2 **(a)** ameliyat sonrası erken ve **(b)** bir ay sonraki görünümü.

Protez bacak kullanımı için amputasyon güdüğünde yeteri kadar yumuşak doku örtüsü olmaması şikayeti ile polikliniğimize başvurmuş. Muayenesinde femur distal kemik dikiş hattında palpasyonunda ağrı ve kemik üzerindeki yumuşak doku örtüsünün yetersizliği mevcut (Şekil 4a, b). Kısaltma osteotomisi tarzında yapılacak olan güdük onarımının protez için ideal uzunlukta kemik miktarını azaltabileceğinden dolayı düşünülmedi. Hastaya ipsilateral inferior pediküllü VRAM flep ile yumuşak doku onarımı yapıldı (Şekil 4c, d). Hastanın takiplerinde herhangi bir komplikasyon tespit edilmedi (Şekil 5a, b).

Olgu 4– Ateşli silah yaralanması sonucu sol uylukta, kemik ve üzerindeki kas-yumuşak doku kayıplı femur kırığı nedeniyle başka merkezde ameliyat edilen 34 yaşındaki erkek hasta

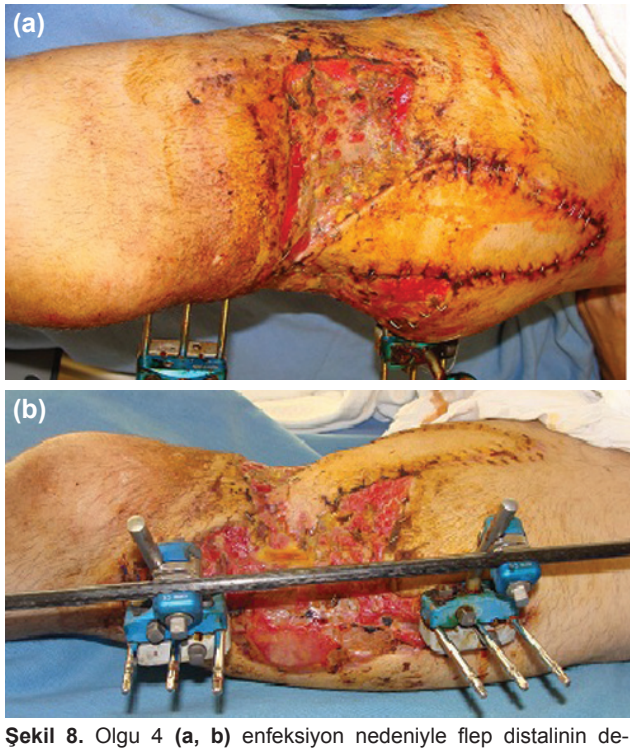


Şekil 4. Olgu 2 **(a)** ampute femurun distalinde kemik yapı (direkt grafi, ön-arka görünüm), **(b)** üzerinde yumuşak doku yetersizliği, **(c)** flebin kaldırılışı ve defekt alana transferi, **(d)** ameliyat sonrası görünüm.



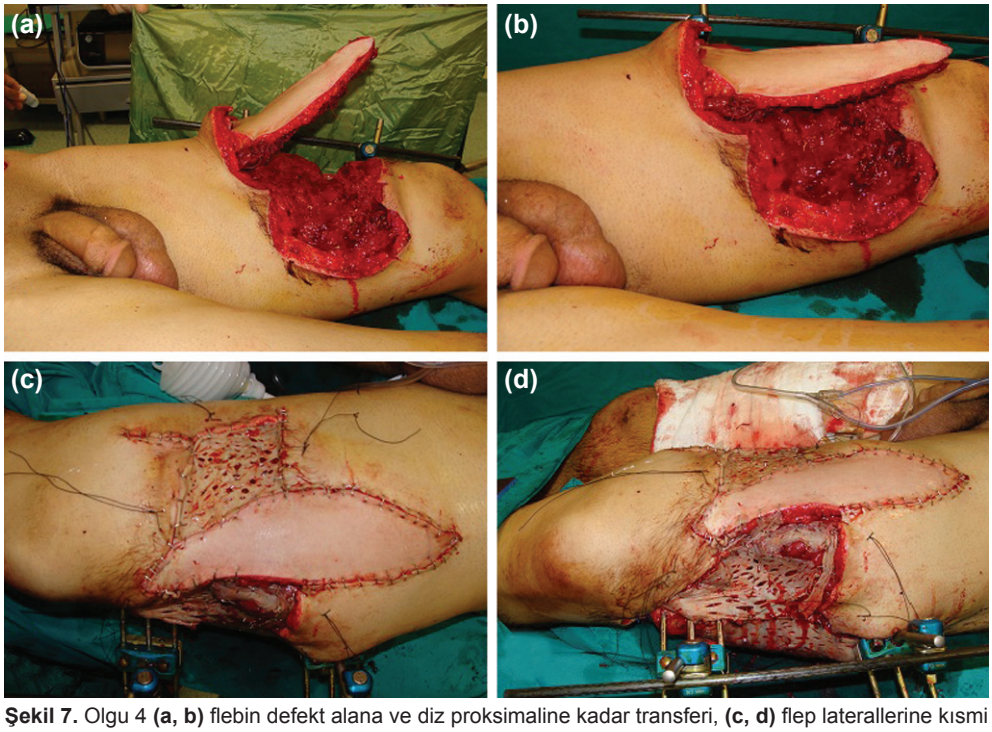
Şekil 6. Olgu 4 **(a)** femurda kemik ve yumuşak doku kayıplı kırık (direkt grafi, yan görünüm), **(b)** direkt grafi, ön-arka görünüm, **(c)** kemiği ortaya çıkaran, 35x22 cm' yumuşak doku kaybı, **(d)** flebin kaldırılışı.

kas-yumuşak doku onarımı için kliniğimize sevk edildi. Muayenesinde femur distalinde kuadriseps femoris kas-tendinöz yapılarında doku kaybı, femur distalinde kemik kayıplı ve kemiği ortaya çıkaran eksternal fiksatör yerleştirilmiş femur kırığı (Şekil 6a, b), yaklaşık 35x22 cm yumuşak doku kaybı (Şekil 6c) izlendi. Hasta debridman sonrası cerrahi teknikte anlatıldığı gibi defektif femur kırığını örtecek şekilde planlanan ispilateral inferior pediküllü VRAM flebi (Şekil 6d) ve flep lateralindeki doku kayıplarına ise kısmi kalınlıktaki deri

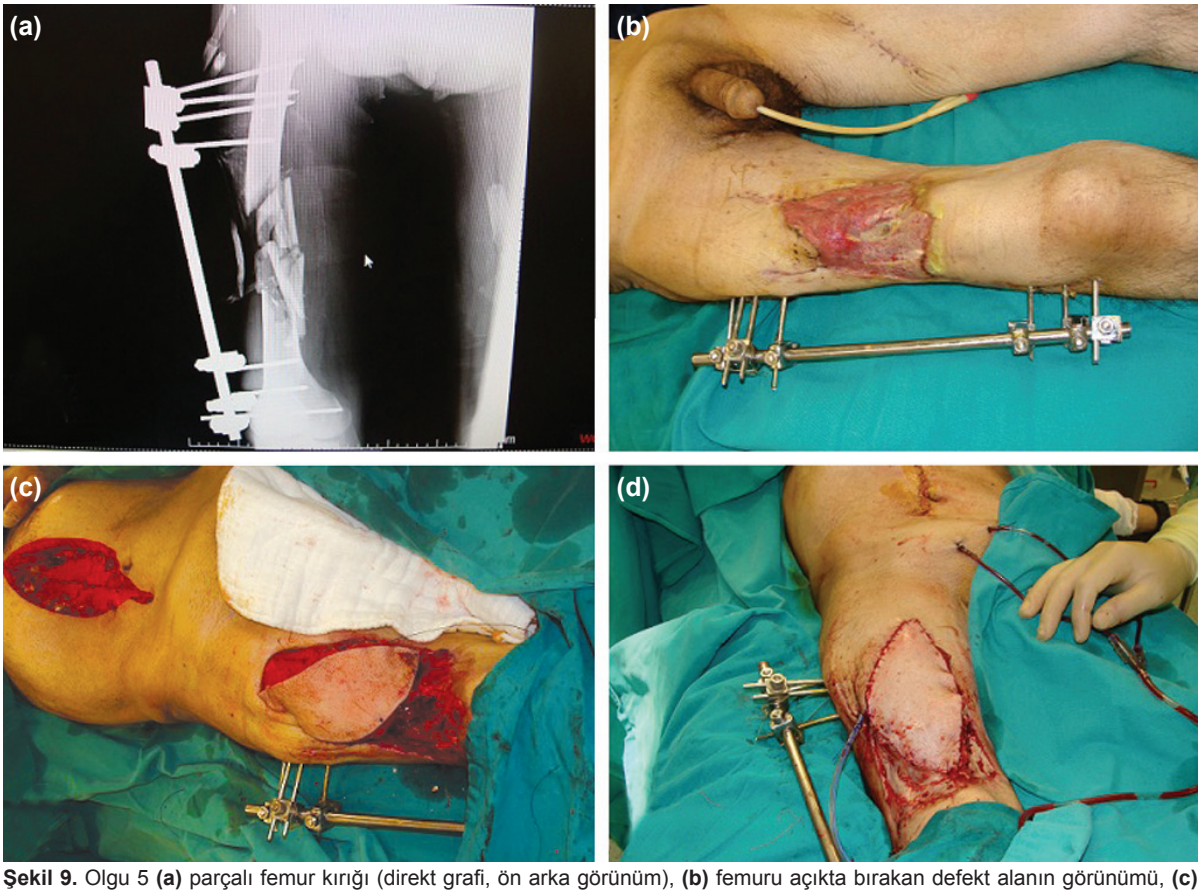


Şekil 8. Olgu 4 **(a, b)** enfeksiyon nedeniyle flep distalinin de-epitelize edilmesi ve kırık içerisine gömülmesi sonrası yedinci gün görünümü.

greftleri (Şekil 7) ile onarım yapıldı. Takip edilen günlerde yara yeri enfeksiyonu üzerine enfeksiyon hastalıkları ile konsülte edilerek medikal tedavilerine imipenem ve vankomisin eklendi. Enfeksiyonda gerileme olmaması üzerine flebin distal yaklaşık 7 cm'lik kısmı de-epitelize edilip femurun kemik



Şekil 7. Olgu 4 **(a, b)** flebin defekt alana ve diz proksimaline kadar transferi, **(c, d)** flep laterallerine kısmi kalınlıkta deri grefti ile onarım.



Şekil 9. Olgu 5 **(a)** parçalı femur kırığı (direkt grafi, ön arka görünüm), **(b)** femuru açıkta bırakan defekt alanın görünümü, **(c)** flebin kaldırılışı ve defekt alana transferi, **(d)** flep laterallerindeki doku kayıplarının deri grefti ile onarımları.

kaybı olan kırık bölgesine gömülmesiyle tedavi edildi (Şekil 8). Pansuman önerisi ile taburcu edilen hastanın yurtdışında başka merkeze femur kırığı nedeniyle intramedüller çivileme ile kırık fiksasyonunun yapıldığı uyluk bölgesindeki tüm yaraların tamamen iyileştiği rehabilitasyon egzersizlerine başlandığı öğrenildi.

Şekil 10. Olgu 5 ameliyat sonrası 10. gün görünüm.

Olgu 5– Yetmiş yedi yaşında erkek hasta ateşli silah yaralanmasının neden olduğu sağ uyluk yaralanması ve yumuşak doku defekti kliniğimize sevk edildi. Muayenesinde eksternal fiksatör ile fiksasyon yapılmış sağ mid-femoral-parçalı-cisim kırığı, nonünion, ostemyelit ve yaklaşık 20x13 cm'lik yumuşak doku defekti mevcuttu (Şekil 9a, b). Hastaya ipsilateral inferior pediküllü VRAM flep ile yumuşak doku onarımıyla flep laterallerine ise kısmi kalınlıkta deri grefti ile onarım yapıldı (Şekil 9c, d). Erken dönem takiplerinde sorun yaşanmadı (Şekil 10). Hasta femur kırık stabilizasyonu için başka merkeze taburcu edildi.

TARTIŞMA

Ekstremite yaralanması olan olgularda ekstremiteyi kurtarmaya yönelik yaklaşımlar daha doğru ve kabul edilir bir tedavi yaklaşımı haline gelmiştir. Ampute olan olgularda ise protezin uygun tarzda kullanılabilmesi ve ekstremite rehabilitasyonunun en iyi şekilde yapılabilmesi için güdüğün yeterli kemik boyutuna ve yumuşak doku desteğine ihtiyaç vardır. Uyluk bölgesindeki yüzeysel doku kayıpları onarımlarında bu bölgedeki kas ve yumuşak doku yapılarının bolluğu nedeniyle lokal flepler veya sadece cilt greftleri ile rekonstrüksiyonlar sıklıkla günlük pratikte tercih edilmektedir. Ancak geniş ve derin de-

fektlerde cilt greftlemeleri veya vakum destekli yara bakımları; ölü boşlukların fazla miktarda olması ve bu boşlukları doldurmada yetersiz kalmaları, kemik veya metalik implantların ortaya çıktığı olgularda ise greft tutabilirliği olmayacağından dolayı uygun tedavi yaklaşımları değildir. Lokal kas fleplerinin kullanılması; kemiği ekspoze edecek derecede geniş defektler için bu bölge kaslarının hipovasküler yapıda ve travma durumlarında ise fibrotik olmasından dolayı tercih edilmemektedir. Ayrıca halihazırda mevcut doku kaybının oluşturduğu morbiditeye ek olarak kullanılacak lokal kas flebinin kendi fonksiyonel kayıplarını da beraberinde getirebilecektir.[15] Serbest fleplerin kullanımıysa; alıcı güvenli damar azlığı ve alıcı damarın travma bölgesine (zone of injury) veya enfekte alana yakınlıkları, yüksek vasküler komplikasyon oranları, mikrocerrahi tecrübe gereksinimi, pediküllü flepler ile kıyaslandığında uzun operasyon süresi gibi dezavantajlarından dolayı nadirdir.[16]

Literatürde pediküllü RAM flebi göğüs duvarı, sternum, perine, pelvik, kasık ve vajina rekonstrüksiyonlarında daha yaygın olarak kullanılmasına rağmen[1,2] uyluk bölgesindeki defekt onarımlarında kullanımı daha nadir bildirilmiştir.[3-9] Brain ve ark. uyluk ve kasık bölgesinde lokalize, çoğunluğunu yumuşak doku sarkomların oluşturduğu ve ameliyat öncesi radyoterapi alan 50 hasta ile en geniş olgu çalışmasına sahip klinik çalışmalarında, yaptıkları 51 RAM flep cerrahisinde total flep kaybının hiçbir olguda rastlanmadığını, sadece iki olguda kısmi flep kaybı gözlemlediklerini, 12 olguda (%24) yara yeri komplikasyonları geliştiğini belirtmişlerdir. Birçok klinik çalışmada alt ekstremite sarkomu nedeniyle serbest veya lokal flep ile ameliyat edilen olgularda yara yeri komplikasyon oranları %19 ile 35 arasında bir oranda bildirilmiştir.[17-19] Ancak tüm bu çalışmalarda yüksek yara yeri komplikasyon oranlarına hastaların ameliyat öncesi radyoterapi almalarının neden olduğu söylenebilir. Çalışmamızdaki bir olguda (Olgu 4) flep transferi sonrası, flep altından ve femur parçalı kırık bölgesinden yara yeri enfeksiyonu gelişti ve flebin distal kısmının de-epitelize edilip defektif kısma gömülmesi ile tedavi edildi.

Lumbo-sakral bölgedeki doku defektleri onarımı en güç alanlardan biridir. Sakral bölge defektleri için bilateral gluteal ilerletme flepleri de tanımlanmış.[13] Ancak radyoterapi alan veya gluteal damarları hasarlı olan olgularda flep güvenli bir şekilde kaldırılamayacağı gibi lomber bölge defektleri için uygun tedavi seçenekleri değildirler. Latisimus dorsi kas flebi lomber ve üst sırt bölgesi defektlerin onarımlarında hem torakodorsal pedikül (proksimal tabanlı) hem de sekonder segmental pedikül üzerinden (distal tabanlı veya ters akımlı flep) kaldırılarak kullanılabilir.[20-22] Olgumuzdaki gibi daha distal defektlerde proksimal tabanlı olarak transferi uygun olmayıp ters veya reverse olarak hazırlanması gerekmekte; ancak, özellikle cilt adası ihtiyacı olduğunda flebin torakodorsal pediküle yakın bölgelerinde venöz yetmezliğe bağlı yüksek oranda flep kayıpları bildirilmektedir.[23] Bunu önlemek için venöz "supercharge" şeklinde anastomazlar tanımlanmıştır.[24,25] Ancak ilave mikrocerrahi deneyimi gerektirmesinin yanı sıra, bu bölgede kolay ulaşılabilir ve güvenli bir vasküler yapıyı bulmak kolay olmadığı gibi olgumuzdaki gibi mayın patlaması ve ilave cerrahi işlemler geçirmiş olgularda imkansız olabilmektedir. Benzer gerekçelerden dolayı serbest fleplerle onarımlar bu bölge defektleri için nadiren başvurulan tedavi seçenekleridir. Her ne kadar Mathes sırt bölgesi defektlerin onarımlarını incelediği ve detaylı tartıştığı çalışmasında RAM flebinden bahsetmemiş[26] olsa da transabdominal RAM flep transferi sakral bölge defekleri için uygun seçenek olarak sunulmuştur.[10-14] Miles ve ark. transpelvik RAM fleple onarımı yapılan 10 sakrektomi defektli çalışmalarında hiçbir olguda kısmi ya da total flep kaybı olmadığını, flep tünelizasyonu sırasında herhangi karın içi problem gelişmediğini ancak beş olguda minör komplikasyon geliştiğini (dördünde minör yara yeri ayrılması ve birinde seroma) bildirmişlerdir.[12] Beş olgudan üçünün ameliyat öncesi dönemde radyoterapi alan hastalar olduğunu ve radyoterapinin komplikasyon riskini artırdığını da ileri sürmüşlerdir. Diğer bir klinik çalışmada 12 kısmi veya total sakrektomili hastada transabdominal RAM fleple onarımlar yapılmış, flep kaybı olmaksızın sadece üç olguda minör yara yeri komplikasyonlar geliştiği belirtilmiştir.[10] Olgumuzda defekt sakral bölgenin süperiorunda L2-L5 omurgalar arasında idi. Bu yönüyle klasik olarak tanımlanmış sakrektomi sonrası transabdominal RAM onarımlarından farklılık göstermektedir. Bu yüzden sadece bu olgumuzda standart VRAM yerine "ekstended" RAM şeklinde modifikasyon yapıldı. Olgumuzdaki gibi geçirilmiş karın operasyonu veya abdominal skarın olması RAM flebinin kaldırılması için kontrendike değildir. Skarın tam orta hatta olması daha lateralde kalan pedikülün sağlam olduğunu düşündürdü. Şüphe duyulan durumlarda manyetik rezonans anjiyografi, bilgisayarlı tomografi anjiyografi veya klasik anjiyografi ile ameliyat öncesi dönemde inferior epigastrik arter bütünlüğü değerlendirilebilmektedir. Bu ameliyatın tek dezavantajı plastik cerrahların batın içi anatomiye yabancı olmasından dolayı genel cerrah desteğine ihtiyaç duyulması ve ameliyat sırasında hastanın pozisyon değişiklik gereksinimidir.

RAM flep transferi sonrası donör alan morbiditesi olarak abdominal "bulge" veya fıtık oranı yaklaşık %12-13 oranlarında bildirilmiştir.[3,4] Çalışmamızda hiçbir olguda abdominal bölge ile ilgili komplikasyon tespit edilmedi. Bu, flep hazırlanması sırasında anteriyor rektus fasyayı mümkün olduğu kadar flebe dahil etmeden hazırlanıp donör alanın primer olarak kapatılmasının sağlanması ve ilave yama kullanılması ile açıklanabilir. Ayrıca flep transferinin alt ektremite rekonstrüksiyonu olan olgularda inguinal ligementin altından yapılması flebin daha distale rahatlıkla transferini sağlayabildiği gibi anteriyor rektus fasyasının arkuat çizginin altında (*arcuate line*) rahatlıkla ve gerilimsiz bir şekilde primer olarak kapatılmasına izin vermiştir. Olgu 1 hariç tüm olgularımızda flep hazırlanması sırasında flebin pubik çıkıntı-simpisis pubis ile olan tüm bağlantıları tamamen serbestlendi ve aynen serbest flep hazırlanışı gibi inferiyor epigastrik arter eksternal iliak artere kadar tamamen iskeletize edildikten sonra defekt alana transfer edildi. Bu, flepte geçici venöz yetmezliğe sebep olmasına rağmen hem flebin daha distale transferini sağladı, hem de arkuat çiz-

ginin altında defektin primer olarak kapatılmasına engel olan kasın pubik bağlantılarının önüne geçişmesini sağladı. Geçici venöz yetmezliğin sebebi olarak flep hazırlanması sırasında pediküldeki geçici vazokonstrüksiyonlar olabileceği gibi pedikülün tünelizasyonu sonrası transferinde gerilimin neden olduğu düşünüldü. Hastaların yatağına alındıklarından itibaren kalça eklemlerinin 30 derece fleksiyone getirilmesi ile flepteki venöz yetmezlik sorunu tedavi edildi. Takip eden günlerde kalça fleksiyon açıları azaltıldı ve alt ekstremite tam kalça ekstansiyonuna (en geç yedi gün içerisinde) getirildi. Tüm bunlara ilave olarak flebin aynen serbest flep gibi hazırlanıp gerilimsiz olarak distale taşınmasının bir diğer avantajı da RAM flebinin standart olarak hazırlanmasına (VRAM gibi) imkân sağlar ve "ekstended" veya modifiye edilmeden ilave abdominal insizyon ve skar gelişimini önler.

Sonuç olarak, çalışmamızda flep hazırlanırken serbest flep gibi pedikül üzerinden ada şeklinde ve pubik bağlantıların ortadan kaldırılması ve uyluk bölgesine inguinal ligementin altından taşınması şeklindeki modifikasyonumuz daha fazla kas-yumuşak doku transferi imkânı sağlar, daha geniş bir rotasyon arkı verir, flebin daha distale taşınmasını kolaylaştırır, donör alanda fasyanın tabakalar şeklinde primer olarak kapatılmasına izin verir ki bu da muhtemel abdominal komplikasyonların gelişimini ortadan kaldırır veya en aza indirger. Ayrıca "ekstended" olarak kaldırıldığında sakral bölgeden daha süperior bölgedeki defekt alanlara taşıma imkânı sağlar.

Çıkar örtüşmesi: Çıkar örtüşmesi bulunmadığı belirtilmiştir.

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ORIGINAL ARTICLE - *ABSTRACT*

Using pedicled rectus abdominis musculocutaneous flaps in thigh and lumber defects

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BACKGROUND: A series of previously described but rarely used variations of the pedicled, extended or vertical rectus abdominis musculocutaneous flap (Extended RAM, VRAM) were reviewed.
METHODS: Skin paddle dimensions, ranged 8 to 28 cm in width and 10 to 35 cm in length, were used in five consecutive patients. Four flaps were placed deep to the inguinal ligament to repair the thigh as proximal to the knee region; the remaining one flap was passed transabdominally to cover the defect of the lumbar region.
RESULTS: No flaps necrosis were seen and in one case wound healing problems required minimal operative intervention.
Successful transfer of the VRAM and extended RAM with low rate of complication for the thigh and lumbar region defects were demonstrated to be safe and reasonable options of flap reconstruction.
DISCUSSION: The flaps had the advantages of being robust and well-vascularized, easy and fast to harvest, and not requiring microsurgery experience.
Key words: Pedicled rectus abdominis musculocutaneous flaps; thigh and lumber defects.

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OLGU SUNUMU

Ateşli silah yaralanmasında atipik seyir

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ÖZET

Ateşli silah yaralanmaları yaygın bir medikal-legal sorun teşkil eden konulardan biridir. Bu tür yaralanmaların oluşturduğu atipik trakt hatları tanı ve tedavide zorluklar çıkarabilmektedir. Bu yazıda. sağ uyluk ön bölgesinden meydana gelen ateşli silah yaralanmasının sağ hemitoraksa uzanan atipik seyrini sunduk. Ateşli silah yaralanması nedeniyle 67 yaşındaki Suriyeli mülteci erkek hasta acil servise getirildi. Sağ uyluk ön medial bölgesinde mermi giriş deliği tespit edildi, ancak çıkış deliği yoktu. Toraks tomografisinde mermi sağ hemitoraksda tespit edildi, hasta diyafragma rüptürü ve akciğer parankim hasarı nedeniyle operasyona alındı. Ateşli silah yaralanmalarında mermi çekirdeğinin saptanamaması durumunda diğer vücut kısımlarının radyolojik görüntülemesi mutlak yapılmalıdır.

Anahtar sözcükler: Ateşli silah; atipik seyir; toraks yaralanmaları.

GİRİŞ

Ateşli silahların özellikle 19. yüzyılın ikinci yarısında büyük gelişim göstermelerine paralel olarak tüm dünyada ateşli silah yaralanmalarıyla oldukça sık karşılaşılmaktadır. Bu tip yaralanmalar eşlik ettiği organ ve damar yaralanmalarına paralel olarak yüksek morbidite ve mortaliteye sebep olabilirler. Toraks içindeki organların hayati önemi ile doğru orantılı olarak penetran toraks travmaları yüksek mortalite ve morbitideye sahiptir.[1,2] Eşlik eden ekstratorasik organ yaralanmaları mortalite ve morbitideyi artıran nedenler olup dikkatli incelenmesi gerekmektedir.

Bu yazıda, sağ uyluk ön bölgesinden meydana gelen ateşli silah yaralanmasının sağ hemitoraksa uzanan atipik seyrini sunduk.

OLGU SUNUMU

Altmış yedi yaşında Suriyeli mülteci erkek hasta ateşli silah yaralanması nedeniyle acil servise getirildi. Yapılan ilk muayenesinde sağ uyluk ön medial bölgesinde muhtemel mermi giriş deliği tespit edildi, ancak çıkış deliği yoktu. Bilinci açık, vital bulguları kararlı seyreden hastanın yapılan fizik muayenesinde ek bulguya rastlanmaması üzerine ekstremite grafisi çekildi. Mermi fragmantasyonları saptanan hastaya, karın grafisi ve akciğer grafisi istendi (Şekil 1). Merminin sağ hemitoraksda olduğunun görülmesi üzerine hastaya torakoabdominal tomografi çekilip radyoloji tarafından değerlendirmesi yapıldığında, karaciğer sağ lob posterior segment inferiyor kesimde yaklaşık 3 cm'lik parankimal laserasyon ve sağ posteriyor pararenal fasiada en kalın yerinde 12 mm ölçülen hematom görünümü izlendi.

Karın tomografisinde serbest hava tespit edilmedi. Hastanın çekilen toraks tomografisinde hemopnömotoraks ve akciğerde kontüzyon olması üzerine hastaya sağ tüp torakostomi uygulandı (Şekil 2). Yaklaşık 350 cc hemorajik drenaj ve masif hava kaçağı tespit edildi. Hasta ilgili bölümler tarafından değerlendirildi. Genel cerrahi ve üroloji tarafından fiziksel inceleme ve radyoloji raporu doğrultusunda konservatif yaklaşım tercih edilmesiyle hasta göğüs cerrahi yoğun bakıma yatırıldı. Masif hava kaçağının ve saatlik toraks tüpü takibinde ilk dört saatte 200 mlt hemorajik drenajın devam etmesi üzerine operasyon hazırlığını takiben hastaya monolümen entübasyon sonrası sağ posterolateral torakotomi uygulandı. Eksplorasyonda diyafragma rüptürü olan hastada sağ alt ve üst loblarda ateşli silah yaralanmasına bağlı trakt oluşumu görüldü. Akciğerde merminin traktı boyunca yoğun hava kaçağı ve aktif parankim kanama alanları tespit edildi. Mermi üst lobdan çıkartılıp hasarlı alanlara pnömorafi uygulandı. Diyafram emilemeyen dikişle kapatıldı. Ameliyat sonrası yoğun bakıma ekstübe olarak alınan hastanın klinik seyrinde komplikasyon gelişmemesi üzerine ameliyat sonrası beşinci günde taburcu edildi.

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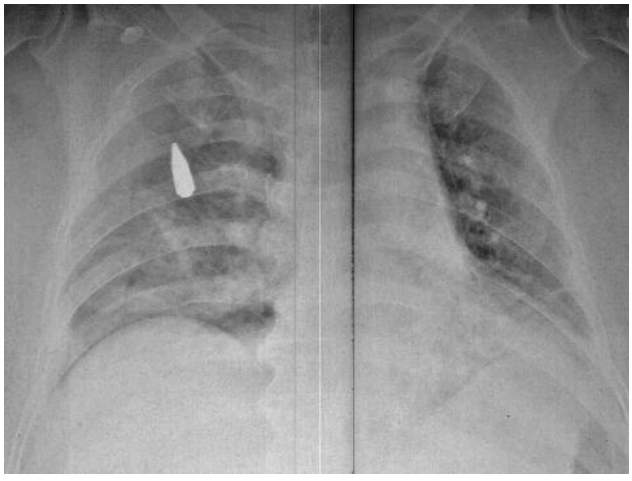


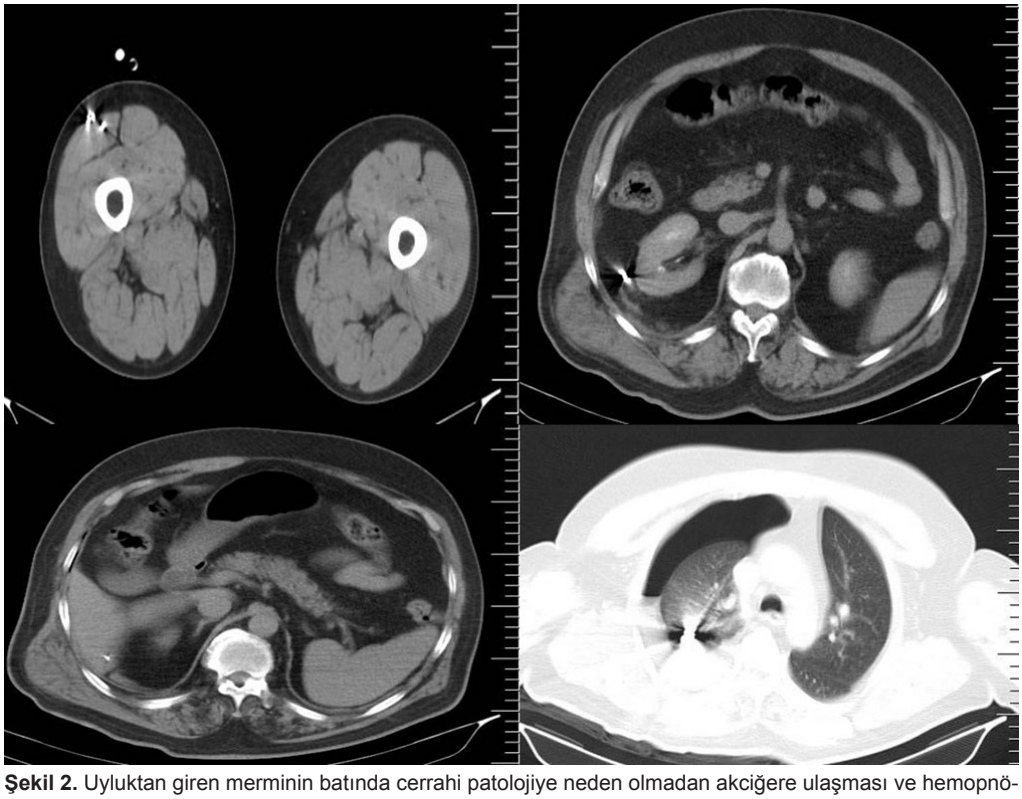
Şekil 1. Ameliyat öncesi akciğerde mermi çekirdeği.

TARTIŞMA

Tüm travmalar içerisinde toraks travmaları oranı %25-30 olup, bu oranın %70'i künt, %30'u ise penetran travmalardır.[3] Toraksa nafiz ateşli silah yaralanmaları pek çok değişik klinik tablo ile sonuçlanabilir. Travma sonucu meydana gelen morbidite ve mortalite hasar gören yaşamsal yapılar nedeniyledir.[1,2] Bu nedenle bu tip yaralanmaları dikkatli bir şekilde değerlendirmek çok önemlidir. Vasküler yaralanma, bronş yaralanması veya geniş pulmoner laserasyonlarda kama rezeksiyondan pnömonektomiye uzanan cerrahi yapılabilir.[4-6]

Ateşli silahlar yüksek veya düşük kinetik enerjili olarak ikiye ayrılabilir. Askeri silahlar genellikle yüksek kinetik enerjili olup, şehirlerde bireylerin kullandığı silahlar genellikle düşük kinetik enerjilidir. Bu tip düşük kinetik enerjili silahların mermileri çarpma ve dokuyu başka bir tarafa itme eğilimindedir, bununla beraber mermilerin rotasyonel karakterlerinden dolayı doku içerisinde seyrettikleri yol değişken olabilir. Ayrıca travmanın gerçekleştiği dokunun karakteri de önemlidir; yüksek elastisite ve düşük dansite dokunun travmadan daha az zarar görmesini sağlar.[7]

Kimi zaman toraks duvarına gelen mermi, deriyi delecek hıza sahip iken kemiği delemez. Bu durumda yönünü değiştirerek cilt altından elipsoid bir yol izler ve tekrar cildi delerek vücudu terk eder. Bu gibi durumlarda giriş ve çıkış delikleri incelendiğinde merminin toraks kavitesine girip çıktığı gibi bir yanılgı oluşabilir.[8] Farklı anatomik vücut alanlarından mermi girişi olup, lezyon bölgesinden çok farklı yerlere merminin ulaştığı olgular rapor edilmiştir.[9] Ancak bizim olgumuzun özelliği en yüksek kinetik enerjiye sahip olduğu uyluk bölgesinden itibaren enerji kaybederek toraksa kadar ulaşan ve akciğerin içine saplanarak kalan, ancak geçtiği karın organlarında hayati tehlike oluşturacak etkiye sebebiyet vermeden enerjisinin en az olduğu bölgede en büyük hasarı oluşturmuş olmasıdır. Ateşli silah yaralanmalarında giriş yerine göre yapılan görüntüleme yöntemlerinde özellikle çıkış deliği olmayan olgularda mermi çekirdeğinin saptanamaması durumunda diğer vücut kısımlarının radyolojik görüntülemesi mutlak yapılmalıdır.



Şekil 2. Uyluktan giren merminin batında cerrahi patolojiye neden olmadan akciğere ulaşması ve hemopnömotoraks görünümü.

Ateşli silah yaralanmalarında durumu stabil olan hastalarda yapılacak doğru değerlendirmeler gereksiz operasyonları engelleyeceği gibi oluşabilecek mortalite ve morbiditelerin de önüne geçilebilmektedir.

Çıkar örtüşmesi: Çıkar örtüşmesi bulunmadığı belirtilmiştir.

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CASE REPORT - *ABSTRACT*

Atypical trajectory of gunshot injury

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ABSTRACT

Gunshot injuries are common medical-legal issues. Atypical tract lines resulting from this type of injuries cause difficulties in diagnosis and treatment. In this paper, a gunshot injury on the right anterior thigh extending to the right hemithorax was presented. A 67-year-old Syrian refugee patient was brought to the emergency service due to gunshot injury. Bullet entrance hole was determined on the right anterior thigh region; however, exit side could not be seen. Bullet was determined on the right thorax at tomography and the patient was taken to operation due to diaphragm rupture and lung parenchymal injury. Other body parts must be examined radiologically for the bullet which cannot be determined at gunshot injury side.

Key words: Atypical tract; gunshot; thoracic injuries.

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CASE REPORT

Traumatic abdominal hernia complicated by necrotizing fasciitis

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ABSTRACT

Necrotizing fasciitis is a critical illness involving skin and soft tissues, which may develop after blunt abdominal trauma causing abdominal wall hernia and representing a great challenge for physicians. A 52-year-old man was brought to the emergency department after a road accident, presenting blunt abdominal trauma with a large non-reducible mass in the lower-right abdomen. A first, CT showed abdominal hernia without signs of complication. Three hours after ICU admission, he developed hemodynamic instability. Therefore, a new CT scan was requested, showing signs of hernia complication. He was moved to the operating room where a complete transversal section of an ileal loop was identified. Five hours after surgery, he presented a new episode of hemodynamic instability with signs of skin and soft tissue infection. Due to the high clinical suspicion of necrotizing fasciitis development, wide debridement was performed. Following traumatic abdominal wall hernia (TAWH), patients can present unsuspected injuries in abdominal organs. Helical CT can be falsely negative in the early moments, leading to misdiagnosis. Necrotizing fasciitis is a potentially fatal infection and, consequently, resuscitation measures, wide-spectrum antibiotics, and early surgical debridement are required. This type of fasciitis can develop after blunt abdominal trauma following wall hernia without skin disruption.

Key words: Abdominal trauma; necrotizing fasciitis; surgery; wall hernia.

INTRODUCTION

Traumatic abdominal wall hernia (TAWH), with a low occurrence rate, is usually caused by high-energy traumas where patients can also present unsuspected injuries in the abdominal organs.

While bowel injuries are less frequent (6%),[1] the organs most frequently affected in blunt abdominal trauma are the spleen (30%), liver (25%), and kidney (20%).

In isolated bowel injury, sepsis originated from perforated intestinal loop is the principal severe postoperative complication and the main cause of death. Delay in presentation, diagnosis and treatment result in poor outcomes.[2] Helical CT can be normal in the early moments, leading to misdiagnosis. Necrotizing fasciitis is a critical illness produced by a blunt abdominal trauma causing abdominal wall hernia.

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CASE REPORT

A 52-year-old man was brought to the emergency department after a road accident (impact after crashing his motorbike into a car), presenting blunt abdominal trauma (handlebar injury) without CET or loss of consciousness.

A preliminary examination was performed, where the patient remained stable with distended abdomen and presented a new apparition, a large non-reducible mass in the lower-right abdominal region, with eroded skin and surrounding hematoma. Early blood tests showed hemoglobin 13.2 mg/l and 21500 leukocytes with neutrophyiia. A chest-abdominal CT was performed, indicating haemoperitoneum in the right hemi-abdomen and a TAWH, without signs of complication. Retroperitoneal and mesenterium hematoma compressing the vena cava were also evidenced.

The patient was admitted in the ICU, with empiric antibiotherapy; three hours later he suddenly developed hemodynamic instability. After resuscitation, a new CT scan was requested

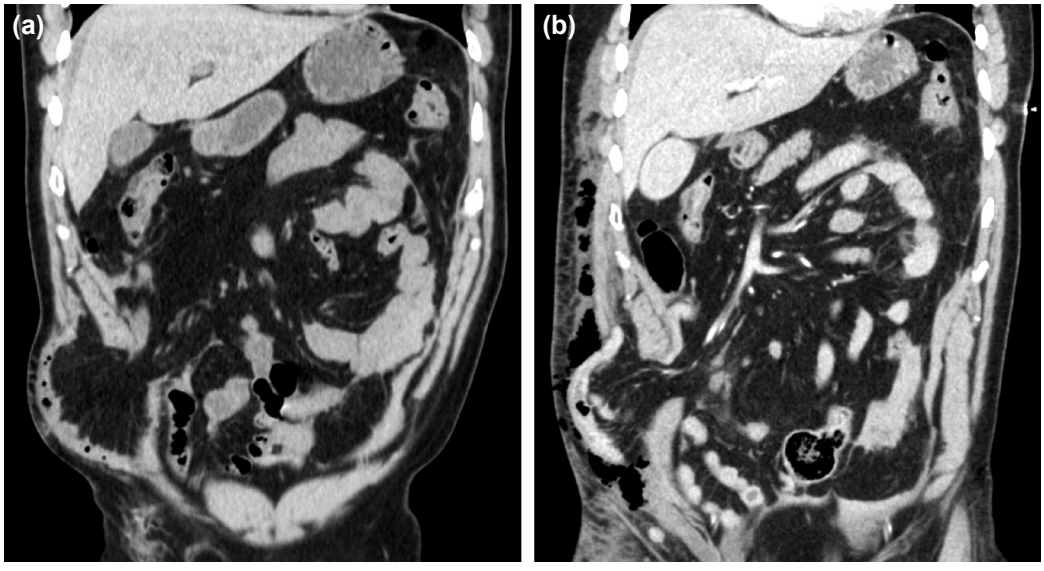

Figure 1. (a) Coronal CT scan upon admittance, showing haemoperitoneum in left abdomen and uncomplicated TAWH with small bowel loop. **(b)** Coronal CT three hours after ICU admission with important subcutaneous and intramuscular emphysema in the right flank and bowel wall thickening in the hernia, suggesting a bowel perforation.

showing significant changes in the hernia including subcutaneous and intramuscular emphysema, and significant bowel wall thickening (Fig. 1). Due to the suspicion of hollow viscus perforation, the patient was transferred to the operating room.

After skin incision, an important subcutaneal collection with intestinal content was appreciated; however, infectious signs in soft tissues were not evidenced. Fascia and muscle were exposed, and perforation of the peritoneum, due to trauma, was observed. A complete transversal section of an ileal loop was also identified. Lavage of abdominal cavity and a manual terminal ileal anastomosis by suturing the mesenteric defect were performed, and the skin remained open.

Five hours after the procedure, the patient suddenly developed a new episode of hemodynamic instability and physical examination revealed induration of surgical wound with dark fluid flowing from it. Crepitation in adjacent skin was appreciated and was also noted in the thorax and right thigh. Due to the clinical suspicion of necrotizing fasciitis, the patient was immediately transferred to the operating room, where wide debridement was performed by excising necrotized tissues and through lavage using H_2O (Fig. 2).

The patient was re-admitted in the ICU, where his critical management continued with wide-spectrum antibiotics (meropenem, linezolid and fluconazole). A microbiological test of wound liquid indicated growth of *E. coli*, *Enterococcus faecalis*, and *Streptococcus mitis* (Fig. 3). He had a slow recovery consisting continued washing of the wound and decreased

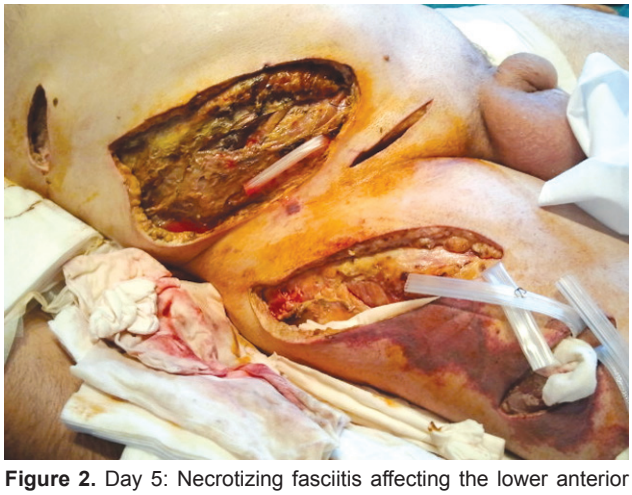

Figure 2. Day 5: Necrotizing fasciitis affecting the lower anterior abdominal wall and right thigh after wide surgical debridement. Penrose drainages were placed in order to prevent retention of secretions and facilitate subsequent washing.

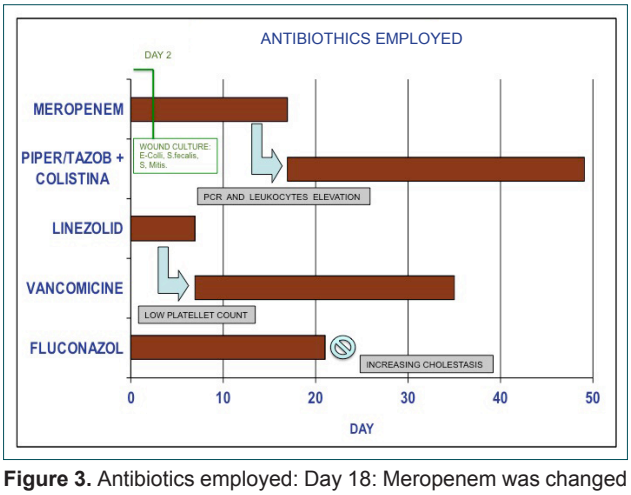

Figure 3. Antibiotics employed: Day 18: Meropenem was changed with the combination of Piperaziline-Tazobactam + Colistine due to cholestasis. Day 8: Linezolid was changed to Vancomycin for thrombocytopenia.

Figure 4. Three months after surgery, showing wound healing.

dosages of drugs. Ventilatory support was discontinued 25 days after the trauma. Three days later, oral intake was initiated and well-tolerated. On the 52nd day, the patient was discharged and remitted to the plastic surgery unit, where his wound continues to be treated to date (Fig. 4).

DISCUSSION

Since the first case of TAWH reported in 1906 by Selby, there have not been many cases published or clinical guidelines validated for its management. This kind of injury is usually produced by high-energy blunt trauma; however, in our case a low-energy impact (handlebar injury) was the origin. Increase in abdominal pressure associated with a combined tangential force was hypothesized to be the cause of muscle and fascial disruption.[2]

Principal CT bowel perforation signs include bowel wall thickening, bowel wall discontinuity, and presence of extra-luminal air.[3] There are studies on CT effectiveness in hollow viscus perforation in blunt abdominal trauma with 26.3% false negatives in the first CT, which decreases when repeated after 24-72h.[4] As observed, in case of high clinical suspicion of bowel perforation with negative CT, a new CT scan is required.

The infection was considered to have developed before the surgery, due to the presence of subcutaneal and intramuscular emphysema in the preoperative CT scan and the presence of intestinal microflora with absence of skin germs in the culture. It is possible that an earlier radical surgery would have improved the patient's outcome, but the first intervention revealed no signs of infection, and thus, did not result in a more aggressive management. However, early intervention in TAWH without delayed diagnosis and intervention leads to a significantly better outcome.[5]

Necrotizing fasciitis (NF), not causing mionecrosis, is a potentially fatal infection involving skin, subcutaneous tissue and muscle. *Streptococcus* group A and *Staphylococcus aureus* (alone or in synergism) are usually considered the initial infecting bacteria shortly after the start of the onset of the disease contamination with their own aerobic and anaerobic microflora.

Regarding microbiological findings, the patient presented NF type I, the most frequent type (70-80%), caused by polymicrobial symbiosis and synergism.[6]

Generally agreed NF therapeutic algorithm include patient's resuscitation, broad spectrum antibiotics, which must later be adjusted to adequately cover organisms obtained in the initial culture, and early debridement of all dead tissue, which should be repeated every 24-48 hours, obtaining gram stain and culture from the wound. Other measures such as hyperbaric oxygen therapy can be considered in the hemodynamically stable patient, if available.

Antibiotherapy alone is not an option since, among other things, tissue hypoxia and ischemia do not permit an adequate delivery of antibiotics to the tissue. The combination of antibiotics should cover a broad spectrum of anaerobes and aerobes, gram-positive and gram-negative. A combination covering all was used in this patient including meropenem-linezolid-fluconazole; however, others such as penicillin, g-clindamycin-gentamicin have also been used with positive results. Due to the increasing number of MRSA infections, daptomycin or linezolid should be used until the infection is excluded (vancomycin is in use, but it has no effect on exotoxin damage).[7]

It is important to remember that in the case of a high suspicion of bowel perforation in a TAWH with negative CT, it should be repeated. Furthermore, if the second CT scan is also negative and there is still high clinical suspicion of bowel perforation, surgical exploration is mandatory.

There are cases reported in the literature linking NF after abdominal surgery procedures, such as inguinal hernia repair[8] or strangulated umbilical[9] and inguinal[10] hernia. However, we did not find previous reports of NF caused by traumatic abdominal wall hernia.

Conflict of interest: None declared.

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OLGU SUNUMU - *ÖZET*

Nekrotizan fasiit ile komplike travmatik abdominal herni

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Nekrotizan fasiit deri ve yumuşak dokuları etkileyen, künt karın travmasından sonra gelişebilen, karın duvarı hernisine neden olan ve doktorlar için büyük bir sorun oluşturan kritik önemde bir hastalıktır. Elli iki yaşındaki erkek bir trafik kazası ardından acil servise künt karın travmasına bağlı sağ alt karın bölgesinde redükte edilemeyen büyük bir kitle ile getirildi. İlk BT herhangi bir komplikasyon bulgusu olmayan bir abdominal herniyi göstermişti. Yoğun bakım ünitesine kabulden üç saat sonra, hastada hemodinamik instabilite geliştiğinden yeniden bir BT taraması istendi. Ameliyathaneye getirildi ve ameliyatta ileal bağırsak segmentinin tümüyle enine yarılmış olduğu saptandı. Cerrahiden beş saat sonra deri ve yumuşak doku enfeksiyonu belirtileriyle birlikte yeni bir hemodinamik instabilite atağı geçirdi. Yüksek bir klinik nekrotizan fasiit gelişme kuşkusu nedeniyle geniş bir debridman yapıldı. Karın duvarı hernisi ardından hastalar karın organlarında kuşkulanılmaayan yaralanmalarla gelebilir. İlk dakikalarda çekilen spiral BT yalancı negatif sonuçlara ve neticede yanlış tanıya yol açabilir. Nekrotizan fasiit ölümcül olabilen bir enfeksiyon olduğundan sonuçta resüsitasyon önlemleri, geniş spektrumlu antibiyotikler ve erken dönemde cerrahi debridman gerekir. Bu tip fasiit künt karın travmasına bağlı deri bütünlüğünün bozulmadığı karın duvarı hernisi sonrası bu tip fasiit gelişebilir.

Anahtar sözcükler: Abdominal travma; cerrahi; duvar hernisi; nekrotizan fasiit.

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CASE REPORT

Complete cervical tracheal transection caused by blunt neck trauma: Case report

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ABSTRACT

This study aimed to report the survival of a rare case of complete tracheal transection followed by blunt neck trauma. A 66-year-old man was presented in the emergency room after a motorcycle accident in which a rope was wrapped around his neck. Although alert, he was in respiratory distress. A computed tomographic scan showed transection of the cervical trachea. Emergency neck exploration revealed that the tracheal laceration had been cut from the tracheal anterior third ring to the posterior first ring and the anterior esophageal wall had ruptured. Laryngectomy, tracheostomy, and esophagopharyngeal anastomosis were performed. Prompt airway management and immediate neck exploration is important for survival in these cases.

Key words: Blunt injuries; rupture; trachea.

INTRODUCTION

Traumatic tracheal injury after blunt neck trauma is rare; however, most patients with complete tracheal transection usually die at the scene due to loss of airway.[1] The few, who survive and arrive at a hospital, pose a diagnostic and therapeutic challenge to the trauma team. These patients may suffer fatal outcomes when misdiagnosed or long-term complications, if treated improperly.[2] Early diagnosis and treatment of tracheal injuries lead to the best outcome. Nevertheless, emergency physicians have limited experience in these cases and have reached no consensus on its management.[3]

In this paper, our experience with one survivor of complete cervical tracheal transection caused by blunt neck trauma combined with esophageal rupture and review of the relevant medical literature were reported.

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CASE REPORT

A 66-year-old man was presented in the emergency room after a motorcycle accident in which a rope was wrapped around his neck. Although alert, he was in respiratory distress. His motor and sensory neurologic signs were normal. He had neck fluctuation on breathing and initial pulse oximetry saturation (SpO_2) was 93%. The vital signs included a blood pressure of 134/80 mmHg, a heart rate of 102 beats/min, a respiratory rate of 22 breaths/min, and an axillary temperature of 36.2°C. Significant crepitus was noted on his neck area. Massive subcutaneous emphysema was present on a lateral cervical spine radiograph and pneumomediastinum was seen on a supine chest radiograph (Fig. 1). Fiber optic bronchoscopy guided endotracheal intubation was planned; however, 10 minutes after the patient's arrival in the emergency room, he showed agitation, cyanotic change, and a decrease in SpO_2 at 81%. Despite aggressive and effective ambu-bagging with manual airway maintenance, SpO_2 did not increase. Therefore, urgent orotracheal intubation was done. There was large amount of blood in the mouth and the right epiglottic area was swollen. His SpO_2 increased to 98% after orotracheal intubation. Computed tomographic scan (CT) of the neck and chest revealed transection of the cervical trachea above the thoracic inlet, pneumomediastinum, and sub-

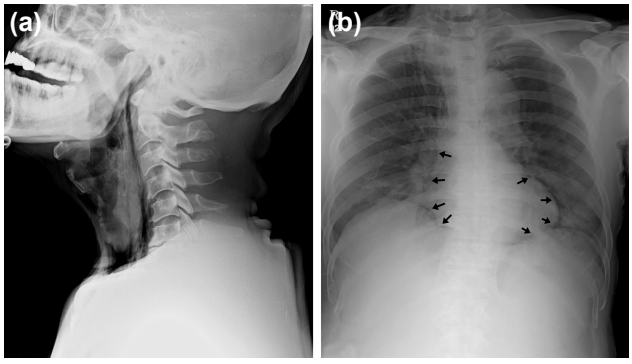

Figure 1. (a) Lateral cervical spine radiograph showing massive subcutaneous emphysema. **(b)** Supine chest radiograph showing pneumomediastinum (arrows).

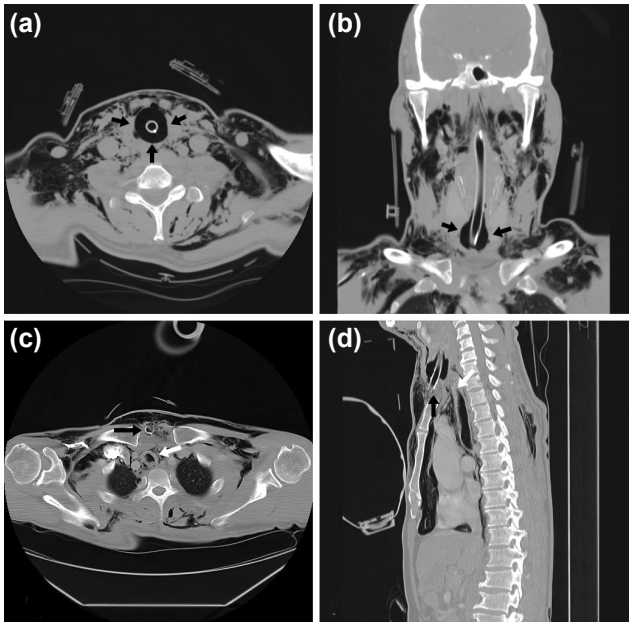

Figure 2. CT scan showing transection of the cervical trachea above the thoracic inlet. **(a)** Axial CT image of the neck showing over-distension of the endotracheal tube cuff (black arrows). **(b)** Coronal CT image of the neck showing over-distension of the endotracheal tube cuff (black arrows). **(c)** Axial CT image of the chest showing the endotracheal tube tip in the upper anterior chest wall, suprasternal notch level (black arrow) and thoracic trachea (white arrow). **(d)** Sagittal CT image of the chest showing the endotracheal tube tip in the upper anterior chest wall, suprasternal notch level (black arrow) and thoracic trachea (white arrow).

cutaneous emphysema in the chest wall and lower neck (Fig. 2). Routine blood samples taken on admission showed a leukocytosis of 12.450/microliters, hemoglobin concentration of 14.4 g/dl, hematocrit of 41.7%, and C-reactive protein of 0.04 mg/dl. The results of the blood chemistry were as follows: serum glucose 170 mg/dL, BUN 20.7 mg/dL, creatinine 0.86 mg/dL, albumin 3.7 g/dL, creatine phosphokinase 320 IU/L, and LDH 244 IU/L. The serum electrolytes and blood gas parameters were as follows: sodium 138 mEq/L, potassium 3.6 mEq/L, chloride 104 mEq/L, pH 7.37, $paCO_2$ 46.3 mmHg, paO_2 36.4 mmHg, and bicarbonate 26.3 mmol/L in room air.

Approximately 90 minutes after arrival in the emergency room, neck exploration was performed by an otorhinolaryngology surgeon. Apron incision was done and subplastymal flap was made from hyoid bone level to substernal notch level. The tracheal laceration had been cut from the tracheal anterior third ring to the posterior first ring (Fig. 3). Urgently, endotracheal tube insertion was done at the lower part of lacerated trachea. Exposured larynx showed frangibility with esophageal rupture. Thus, total laryngectomy was performed, and closed thoracostomy was carried out for right pneumothorax. Esophagopharyngeal anastomosis was conducted by thoracic surgeon for esophageal rupture, which was pedunculated on the anterior wall; the posterior wall was intact. The patient was managed postoperatively with pain control and antibiotics. As an abscess formation was found at the left of the tracheostomy site, an iatrogenic fistula formation was made for the pharyngocutaneous fistula. Fistula repair was performed four times during the following one year and fistula recurrence was not reported up to the following next year. The patient is now in tracheostomy state and able to feed orally.

DISCUSSION

The incidence of traumatic tracheal injuries seems to be roughly 0.5% to 2% among individuals sustaining blunt trauma, including blunt trauma to the neck.[4] Main types of blunt injuries are high-impact blunt compression injuries such as motor vehicles accidents (59%), followed by crush injuries (27%).[5] In blunt injuries, intrathoracic trachea and main stem bronchi injury account for 62%, cervical trachea 23%, and lobar bronchi 15%.5 Most common presentations are respiratory distress, dyspnea, poor gas exchange, and hemoptysis.[5] Cyanosis and serious respiratory embarrassment is present in 30% of the cases. Another common symptom is hoarseness or dysphonia, occurring in 46% of the patients.[4] The most common signs of airway injury reported in most series are subcutaneous emphysema (35%-85%), pneumothorax

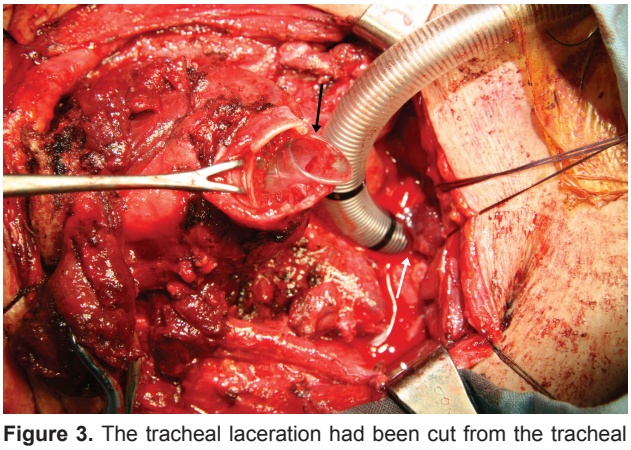

Figure 3. The tracheal laceration had been cut from the tracheal anterior third ring to the posterior first ring. Orally intubated endotracheal tube tip was placed in out of trachea (black arrow). Endotracheal tube was inserted at lower part of completely transected trachea (white arrow).

(20%-50%), and hemoptysis (14%-25%); however, the lack of specificity and the occult nature of the injury frequently result in a delayed diagnosis.[6]

Deep cervical emphysema and pneumomediastinum are seen in 60% of the patients with tracheobronchial injuries.[4,7,8] Blunt trauma is often associated with multiple injuries involving not only the chest, but also the abdomen, head, and orthopedic structures.[4,9] Cervical trauma of the airway frequently involves the esophagus, recurrent laryngeal nerves, cervical spine and spinal cord, larynx, and carotid arteries and jugular veins.[4] Combined transection of the cervical trachea and esophagus, as a result of blunt trauma, is a rare injury accounting for less than 1% of trauma cases seen in major centers.[10]

Many tracheobronchial injuries are not diagnosed immediately (25-68%). Delayed diagnosis is more commonly seen with left-sided injuries.[5,8] Physicians need to maintain a high index of suspicion related to nonspecific signs such as dyspnea, cough, subcutaneous emphysema, and hemoptysis.[11] The mechanism of injury, vocal changes, and rapidly expanding subcutaneous emphysema in the neck are important clues.[11] Clinical examination is followed by radiologic imaging, angiography, computed tomography, and tracheo-bronchio-esophagoscopy.[12]

Accurate interpretation of the chest radiograph is essential in the early diagnosis of occult upper-airway injury.[13] The preponderant findings on chest radiograph include subcutaneous emphysema, pneumomediastinum, pneumothorax, and air surrounding the mainstem bronchi.[13] The best diagnostic investigation is bronchoscopy; flexible bronchoscopy should be carried out first to determine the location and extent of the injury.[5,14-16] However, the bronchoscopic procedure is precarious and characterized by abundant bleeding in the respiratory tract and a rapid drop in arterial oxygen saturation, which are all factors precluding diagnostic confirmation.[6]

A CT scan can be performed if diagnosis is uncertain on plain films.[7,11] Preoperative CT can be useful in assessing associated laryngeal injuries or other unsuspected chest injuries that should be dealt with at the time of surgical exploration. CT is contraindicated in hemodynamically unstable trauma patients or patients with unstable airways.[4] Helical CT with 3D reconstruction should be considered a suitable 'screening' test in a trauma patient suspected of tracheal rupture and may help the clinician in the decision to perform a bronchoscopy on the patient.[6]

The primary initial goals are stabilization of the airway, reversal of shock, relief of the pneumothorax, and determination of the extent and location of injury.[4,8] The management of tracheobronchial injuries, depending on the severity, consists of emergency operation in cases of tracheal rupture, hemorrhage or esophageal injury, or of selective operation.[12] Patients who show respiratory distress, are unstable hemodynamically, or who have clinical suspicion of an airway injury should be intubated immediately with in-line cervical stabilization, preferably with the guidance of a flexible bronchoscope, as described previously.[4,11] Airway manipulation can exacerbate a tracheal injury, hence careful orotracheal intubation is considered to be the only option available before transport.[16]

Debridement and primary repair is the treatment of choice and good postoperative recovery has been reported.[5] Surgical repair is indicated when a transmural tear longer than 1 cm causes a pneumothorax unrelieved by tube thoracostomy. Complete transection of the trachea should be managed by careful suturing and being cautious to avoid damage to the recurrent laryngeal nerves. While small lacerations have been successfully managed conservatively, primary repair of a tracheobronchial rupture is the treatment of choice.[8] For most cervical tracheal injuries, urgent tracheostomy is the best method for airway control.[16] Patients with suspected tracheal injuries, who are clinically stable and oxygenating at greater than 90% SpO_2, should not be intubated and treated only with high flow oxygen. This recommendation may have to be urgently modified in patients presenting with hypovolemic shock or altered mental status from brain injuries.[13,16] In this case, patient was unstable and unable to maintain airway. Urgent orotracheal intubation was done. Even though the endotracheal tube was placed out of trachea, ventilation and oxygenation was maintained by positive ventilation. As the case stands above, if the patient is unstable, it is our belief that oral intubation should not be delayed and urgent orotracheal intubation must be considered.

The prognosis of the patient is largely dependent on an early diagnosis and good interdisciplinary management.[12] Prompt airway management and immediate neck exploration is important for survival in these cases.

Conflict of interest: None declared.

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OLGU SUNUMU - *ÖZET*

Künt boyun travmasının neden olduğu komplet servikal trakeal transeksiyon: Olgu sunumu

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Bu yazıda, künt boyun travması sonrası seyrek görülen ve sağ kalan bir komplet trakeal transeksiyon olgusu sunuldu. Altmış altı yaşında erkek hasta bir motosiklet kazası sonrası, boynunu bir halata kaptırmış vaziyette acil servise getirildi. Bilinci açık olmasına rağmen solunum sıkıntısı çekiyordu. Bilgisayarlı tomografi taraması servikal trakea transeksiyonunu gösteriyordu. Acil boyun eksplorasyonu trakea laserasyonunun trakea anteriorda 3. halkadan posteriorda 1, halkaya uzandığını ve ön özofagus duvarının yırtılmış olduğunu gösteriyordu. Larengektomi, trakeostomi ve özofagofarengeal anastomoz yapıldı. Bu olguların sağkalımı için acilen havayolunun açılması ve hemen boyun eksplorasyonu yapılması önemlidir.

Anahtar sözcükler: Künt travmalar; rüptür; trakea.

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CASE REPORT

Right ventricle collapse secondary to hepatothorax caused by diaphragm rupture due to blunt trauma

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ABSTRACT

Traumatic diaphragm ruptures occur frequently after motor vehicle accidents through penetrating traumas. In 90% of the patients, traumatic diaphragm rupture commonly coexists with other organ injuries. Posteroanterior chest x-ray, computed tomography, magnetic resonance imaging, upper gastrointestinal system contrast-enhanced examinations, and thoraxoscopy/laparoscopy are several modalities which can be used for diagnosing traumatic diaphragm rupture in clinical practice. A case of right ventricle collapse secondary to hepatothorax caused by diaphragm rupture was presented in this study. Patient was diagnosed by posteroanterior chest x-ray and computed tomography. Emergency surgery was planned due to hemodynamic instability. When mechanical pressure on the right ventricle disappeared, hemodynamic improvement was observed simultaneously.

Key words: Mechanical stress; right ventricle collapse; traumatic diaphragm rupture.

INTRODUCTION

Traumatic diaphragm rupture (TDR) is a rare, life-threatening clinical condition occurring after an excessive increase in intra-abdominal pressure.[1] It has been reported in 1-7% of the patients with major blunt traumas and 10-15% of the patients suffering from penetrating traumas.[2,3] Over 90% of patients, TDR exist with concomitant organ injuries, which is the main factor leading to death or major complications.[4,5] Intrathoracic herniation of abdominal organs following diaphragmatic injury is a rare clinical condition difficult to diagnose.[6] Stomach, spleen and colon are the most frequently herniated organs due to the more occurrence of left sided diaphragmatic ruptures with a reported ratio of 25 to 1.5.[2]

In this study, a case of a 55-year-old woman with right ventricle collapse secondary to hepatothorax caused by right diaphragm rupture following an isolated blunt thoracic trauma was reported.

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CASE REPORT

A 55-year-old women was admitted to our emergency department about twenty-five minutes after having a traffic accident. Although she had a history of hypertension, she was hemodynamically compromised on admission. Patient's heart rate was 118 beats/min with sinus tachycardia, blood pressure was 80/50 mmHg, and pulse arterial oxygen saturation was 83% without taking O_2. Jugular venous distention and abdominal tenderness with palpation were present. She had difficulty in breathing and her respiratory sounds decreased during the auscultation of the right hemithorax. Chest X-ray demonstrated elevated right hemi-diaphragm (Fig. 1a). Thorax CT was consequently performed, showing the rupture of right hemi-diaphragm and dislocation of liver into the right hemithorax (Fig. 1b). Due to findings of cardiac tamponade, the patient was urgently transferred to the operating room and underwent an exploratory midline laparotomy in order to remove the tamponade. Right sided diaphragmatic rupture and intra-thoracic herniation of the liver causing mechanical compression of the right ventricle was detected during the operation. Relocation of the liver into the abdominal cavity was performed, and then, the diaphragm was sutured and a chest-drain was placed. After surgical relocation of the liver

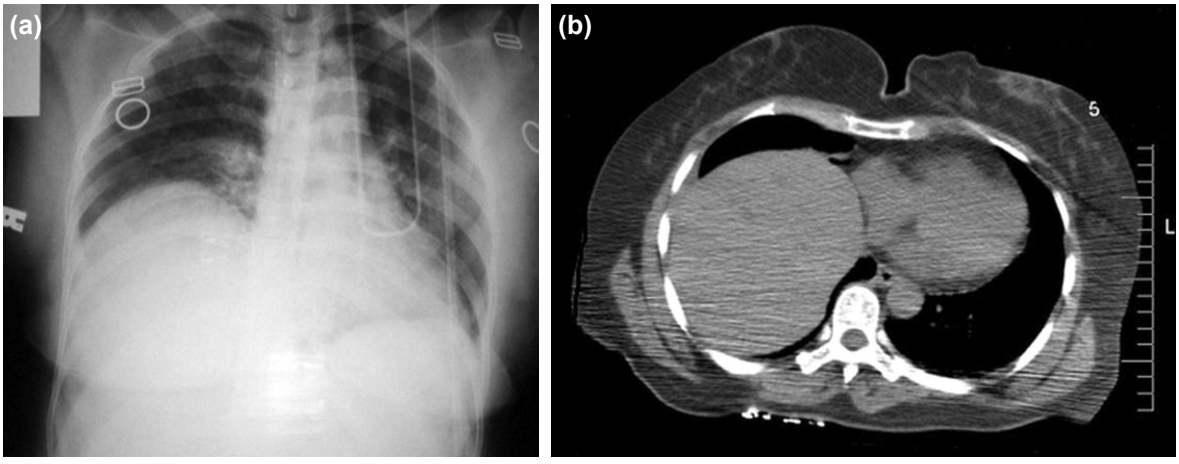

Figure 1. (a) Chest radiography of the patient showing elevated right diaphragm. **(b)** Chest computed tomography image of the patient showing the right ventricular collapse.

into the abdominal cavity and repair of the diaphragmatic rupture, chest X-ray was repeated showing the normal position of right diaphragmatic border. Postoperatively, the patient's clinical course was good and she was discharged on the fifth day of operation.

DISCUSSION

Pressure gradient between the abdominal cavity and thorax is 2-10 mmHg. When blunt traumas exceed the threshold of the diaphragm elasticity, ruptures occur.[7] These ruptures are frequently seen on the left side of the diaphragm.[8] Clinical characteristics of patients with diaphragmatic rupture are silent and non specific. In the acute phase, patients are usually admitted to the emergency setting with co-existing injuries that may obscure the diagnosis, which is responsible for major complications and deaths. Thoracic pain, cough, tachypnea and dyspnea are among the most commonly reported symptoms.[9]

Posteroanterior (PA) chest x-ray, computed tomography (CT), magnetic resonance imaging (MRI), upper GIS contrast-enhanced examinations, and thoraxoscopy/laparoscopy can be used in TDR diagnosis. PA chest x-ray is a simple and valid test diagnostic in 66% of the patients. These chest x-rays display hemi-diaphragm elevation, gas shadow in the thoracic cavity, absence or suppression of diaphragm shadow, and mediastinal shift.[10] On the other hand, its preoperative diagnostic value is limited in the presence of concomitant pleural effusion, atelectasia, and pulmonary contusion. When the diagnosis of TDR is doubtful, the preferable radiodiagnostic method is CT. Abdominal and thoracic computed tomography scans remain highly specific methods for the establishment of a preoperative diagnosis in the acute care setting.[11]

Right sided diaphragmatic ruptures are rare conditions presenting with non specific clinical and radiological findings. Therefore, it is associated with high mortality rates. Hepatothorax represents a rare and severe complication of right diaphragmatic rupture.[12] Herniation of the liver into the thoracic cavity may compromise pulmonary and cardiovascular functions through severe atelectasis of the right lung and compression of the mediastinum.

Treatment is possible with laparotomy, thoracotomy or a combined approach. Preferred technique can vary between patients. Surgical repair of the hepatothorax should be urgent and consist liver relocation and repair of the diaphragmatic defect through a trans-thoracic or trans-abdominal approach.[3] The use of interrupted or continuous non-absorbable suturing along with the intra-thoracic placement of chest tubes represents classical strategy.

Conclusion

A case of right diaphragmatic rupture with severe hepatothorax complicated by cardiovascular collapse owing to compression of the mediastinum was presented here. Cardiac tamponade is a life-threatening condition. When clinicians encounter cardiac tamponade, they are often directed to pericardial effusion due to major vascular injury or cardiac contusion after blunt trauma. Thus, preoperative detection of concomitant pathology such as hepatothorax because of a diaphragmatic rupture is crucial to understand the underlying cause for development of tamponade after blunt trauma. Therefore, physicians have to maintain a high level of clinical suspicion when they encounter patients with sudden onset of respiratory distress or upper abdominal symptoms after a major blunt thoracic or abdominal trauma. In this case, right sided diaphragmatic rupture was complicated by cardiovascular collapse, leading it to be diagnosed and treated as fast as possible. The success of therapy in TDR patients is directly related to concomitant organ injuries.

Conflict of interest: None declared.

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OLGU SUNUMU - *ÖZET*

Künt travma nedeniyle oluşan diyafram rüptürünün sebep olduğu hepatotoraksa sekonder sağ ventrikül kollapsı

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Travmatik diyafram rüptürü genellikle motorlu araç kazasına bağlı penetran travmalar sonucunda meydana gelir. Olguların %90'ında diğer organ yaralanmaları ile beraberdir. Direkt grafi, bilgisayarlı tomografi, manyetik rezonans görüntüleme, kontrastlı üst gastrointestinal sistem incelemesi ve torakoskopi/laparoskopi klinikte tanı amaçlı kullanılan yöntemlerdir. Biz bu olguda diyafram rüptürü sonrası karaciğer herniasyonuna sekonder gelişen sağ ventrikül kollapslı bir hasta sunduk. Hastanın tanısı arka-ön akciğer grafisi ve bilgisayarlı tomografi ile konuldu. Hemodinamisi kötü olan hastaya acil cerrahi planlandı. Sağ ventrikül üzerindeki mekanik basınç ortadan kaldırıldığında eş zamanlı hemodinamik iyileşme gözlendi.

Anahtar sözcükler: Mekanik stress; sağ ventrikül kollapsı; travmatik diyafram rupture.

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